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THE FUTURE OF CACAO RESEARCH.

THE Fifth Report on Cacao Research*, which has recently appeared, sets out in detail the progress made in the various lines of investigation since the publication of the previous report, and, as the recent report covers the final year over which it was initially arranged that research should be carried on, both the Botanical and Chemical Sections include a brief retrospective survey of the work since its inception.

A summary of the position reached in early 1935 appeared in the July issue of *Tropical Agriculture* for that year. A more recent survey of research carried out on the Botanical side is contained in the lecture given by Professor E. E. Cheesman to Trinidad planters in March, 1936 (*Tropical Agriculture*, Vol. XIII, No. 5).

The Report just issued indicates that from the botanical standpoint the fifth year of research has brought to a close certain operations which were the necessary prelude to controlled experimental work on a large scale. A system of propagating cacao vegetatively on its own roots has been worked out, and the methods used can safely be applied to experimental material in the future. The material itself has been chosen with care, and the description of the types on the Selection List has been concluded. The study of varied trees in the field with a view to assessing the influence on yield of certain botanical factors has been carried to a point where it has become necessary to observe the behaviour of uniform material under varying conditions for elucidation of phenomena already noted.

The future programme aims at working with controlled material. Selected trees are to be tested by the behaviour of their progenies. Seedlings are to be distributed over various soils, so that parental influence on yield can be estimated with accuracy. The system of vegetative propagation will be used to supply a hundred uniform trees derived from each selection. The resulting ten thousand trees will be planted in a carefully designed experiment which will enable comparisons to be carried out on a statistical basis with regard to a number of points of agricultural importance, in addition to the paramount considerations of quality and yield. With this in view, attention is now being given to propagation, and to the provision of suitable nurseries.

In addition, it is felt that, although a wide range of botanical material is already present in the Island, a beginning should be made in the collection of types not represented here, as such

* The Fifth Annual Report on Cacao Research, 1935, Trinidad.

a collection would place future cacao breeders in a much stronger position as regards the securing of suitable breeding material.

The Chemical and Ecological Section has progressed considerably in the investigations it has undertaken. These have included studies of "good" and "bad" environments as regards soil and atmospheric conditions, soil surveys of the main cacao soils of Trinidad, Tobago, and Grenada, field manurial trials, examination of the relations between the chemical composition of the tree and the nutrient content of the soil, diagnosis of soil nutrient deficiencies, and estimations of the effects on the soil of organic surface litter, of manganese, and of phosphate in soils containing gypsum.

It is established that "good" environments show uniformly maintained levels of soil and atmospheric moisture. Trees in such areas are not exposed to sudden fluctuation, and owe their protection largely to shelter from air currents as well as to efficient drainage, and suitable soil texture. The chief vegetative activities of the tree, such as flushing, flowering, and setting fruit, appear to be connected with certain changes in the moisture relations of the plant.

The question of the distribution of available phosphate, potash, and nitrogen in local cacao soils has been given careful attention. As regards available phosphate, it was found that this is deficient in cacao soils of heavier types, and that these soils bear trees of low productivity. The next step made was to institute a series of experiments in which phosphate is supplied where it is considered deficient. This is now being done and the initial experiments are to be widely extended by the Officers of the Trinidad Department of Agriculture under the new Cacao Relief Scheme.

A separate investigation on gypsum is being carried out to ascertain the reasons for the depressing effects which it is known to exert on growth and yield of cacao. An interesting relation between this question and that of available phosphate has been revealed by the discovery that phosphate-deficient soils containing gypsum fail to respond to phosphatic manure.

Many cacao soils of the sandy type in Trinidad and Tobago have been found to be deficient in available potash. Yields of cacao are low on these soils, and it has been found that the application of potassic manures produces a very marked response. This finding has led to the inauguration of field experiments with potassic manures in suitable areas during the Dry Season of 1936.

The third principal nutrient, nitrogen, is known to be rarely deficient in local cacao soils. Where shortage does occur it is mainly due to erosion by rain of the organic layer at the surface.

The reaction of cacao soils is extremely variable within very short distances. It is accordingly difficult to generalize in stating what is most suitable for cacao, but the trend of evidence suggests that a neutral or slightly alkaline reaction is the most satisfactory. Tentative experimentation has shown that heavy, acidic soils, deficient in phosphate, respond favourably to the addition of ground limestone. Application of lime is accordingly included in the manurial research programme of the Trinidad Department of Agriculture.

Of the lesser known soil minerals, manganese seems to be relatively important in cacao soils. It is present in greatest amount in soils derived from igneous rocks or calcareous sedimentary deposits, and is generally found in greater quantity on "good" cacao soils than on "bad". There is some indication that soils of the more alkaline type contain the greatest amounts of manganese.

In view of the importance of nutritional deficiency, investigations have been carried out with the object of facilitating diagnosis of abnormal nutrient status. Leaf symptoms and growth habit of cacao itself have been found of value in this respect. Potash deficiency in the plant is revealed by the leaves: the lateral and apical margins show browning in a crenulated pattern. Phosphate deficiency is not so easy to observe, but it is characterised by long, thin, drooping side branches bearing an apical tuft of leaves, while nitrogen deficiency is shown in stunted growth and pale green leaves, though other factors may produce the same effect. In addition, a technique has been developed for comparing ratios of N, P, and K found by chemical analysis of leaf tissue, and by this means it is possible to determine any deficiency of nitrogen, potash, or phosphate in the soil around the tree bearing the leaves examined. One useful outcome of this work should be the determining of those soils in which nutrient balance is so poor that the soil cannot be expected to grow cacao profitably in any circumstances.

Biochemical investigations are already under way in an endeavour to resolve the factors which collectively determine "quality" in cacao. Raw and fermented material from trees belonging to the different groups of cacao will be analysed in detail. It is intended that observations shall be made on the changes in the tannin of the bean during fermentation, and probably the effect on the composition of the beans of manurial treatment of the parent trees will be brought up for consideration.

The research programme as a whole must of necessity be of long duration. The information which is being sought is bound up with the fundamentals of the biochemistry of cacao. Results will arrive sporadically, and, considered singly, are not likely to be spectacular. These considerations, however, have no bearing on the importance of the results which are reached. As it is carried on, the programme is constantly shedding fresh light on the bionomics of cacao—one has but to peruse the reports of the first five years to see what has already been accomplished—and when it is completed, the accumulated evidence should give a clear picture of the requirements of the cacao tree, and of the environmental conditions under which it will be profitable to grow it. By then the botanical researches will have produced high yielding types for populating the areas classified as suitable for them.

A NEW METHOD OF CURING SMALL QUANTITIES OF CACAO.

By J. A. McDonald.
(*Chemist for Cacao Research.*)

I. Introduction.

Cacao produced by peasant proprietors accounts for approximately two thirds of the world's total production, and this enormous quantity of cacao, in the neighbourhood of 350,000 tons annually has all the faults of cacao fermented in separate small quantities. Thus, peasants' cacao is recognised by manufacturers to be of inferior quality and lower value than estates' cacao, the lower quality being in large measure due to the inferior methods of preparation employed by small holders. In this article a new fermentation method is described with which it is possible to ferment separate small quantities of cacao so that the final product is equal in appearance and value to estates fermented cacao.

Cacao Fermentation.

The process of fermentation or "sweating" is the recognised method of preparing fresh cacao beans for the market throughout the cacao-producing countries of the world. The fermentation of the beans greatly improves the quality of the cacao from the point of view of the manufacturers who are prepared to pay a substantial premium in price for properly fermented beans. During recent years, a large number of scientific workers in different parts of the world have investigated fermentation problems, and they have accumulated valuable knowledge of the fundamental processes involved. In spite of this, there has been little or no change in the cacao fermentation methods in common use to-day from those employed in ancient times, long before exact knowledge was available of the biological activities of enzymes, yeasts and bacteria.

The fermentation of cacao in large batches presents few difficulties to the experienced planter provided that reasonable care and supervision are exercised. The owner of a fairly large cacao property has therefore no difficulty in carrying out a proper fermentation, producing well-fermented cacao beans of the quality desired by the manufacturer. This may largely explain the lack of progress in the application of scientific theory to the practice of cacao fermentation. There is, probably, still room for improvement in the fermentation of estates' cacao, but, in order to supersede the older methods, any suggested new method would have to show an appreciable increase in quality of the final product, as well as being equally easy and cheap to apply. For the purpose of curing large batches of cacao, the chemist or biologist has not yet devised a method which gives a final product of such good all round quality as the traditional methods of fermentation.

Fermentation of Small Quantities of Cacao.

In the case of the small peasant proprietor (holding ten acres of cacao land or less), the fermentation problem presents an entirely different aspect. A single picking on a small property may often amount to no more than fifty pounds to one hundred pounds of wet cacao, and the practical difficulties of obtaining a satisfactory product, when such small lots of cacao are fermented by the usual methods, are well recognised. The trouble arises through the large area of surface exposed in relation to the volume of the mass of cacao beans so that too great a loss of heat occurs. The high temperatures requisite for killing the embryo of the bean are therefore never attained, and the internal changes associated with proper fermentation do not take place or are incomplete. A small bulk of cacao is also apt to dry out too quickly. In an endeavour to increase the quantity of cacao available for fermentation, the small holder usually picks his cacao only at long intervals and includes unripe and overripe pods in his picking. The net result of all these adverse factors is that the majority of the beans are unfermented or only partially fermented, some are germinated, and those occurring at the edges are dried up and shrivelled, or may be covered with obnoxious and unsightly moulds. Peasants' cacao is therefore recognised by the manufacturers to be of poorer quality and lower value than estates' cacao.

The crux of the fermentation problem appears to be the protection of small quantities of cacao from excessive evaporation and cooling. If this can be done effectively and cheaply, then there is no reason why a good quality product should not be obtained by the ordinary method of natural fermentation which has proved satisfactory with large quantities under estate conditions.

In the course of biochemical investigations carried out by the Chemical Section of Cacao Research at the Imperial College of Tropical Agriculture, the necessity arose for fermenting separate small experimental samples of wet cacao. In connection with this work the writer has devised a solar fermenting frame which possesses the following advantages, (1) a blanket of warm air at a temperature ranging from 100°F. to 150°F. (38°C. to 65°C.) is maintained round the sweat box for a period of eight hours in the day, (2) a humid atmosphere can be maintained round the sweat box, thus preventing excessive evaporation, (3) the apparatus required is simply and cheaply constructed, (4) the source of heat costs nothing.

Details concerning the design and construction of this fermenting frame, and preliminary experiments carried out with the new method are published in the Fifth Annual Report on Cacao Research, 1936, Chemical and Ecological Section. In the present article, a brief outline is given of the new method of fermentation and of the design and construction of the fermenting frame.

The results of preliminary fermentation experiments are summarised, and the possible practical importance of the new method, as a solution of peasant fermentation problems, is discussed in detail. For full experimental details concerning the preliminary trials, and a discussion of various theoretical considerations involved in this new fermentation process, reference should be made to the original article in the Fifth Annual Report on Cacao Research.

II. The Solar Fermenting Frame for Curing Small Quantities of Cacao.

In most tropical countries where cacao is grown, the sun is a constant and reliable source of heat throughout the day-time. In Trinidad, there is an average of six to eight hours bright sunshine each day during the eight months in which the bulk of the cacao crop is picked. The temperature of dark-coloured objects exposed to direct sunlight and adequately insulated reaches an average maximum temperature of 150°F. or 65°C. It seemed feasible therefore to utilise this cheap and constant source of heat for producing temperatures whose range lies almost exactly within the optimum limits known to be necessary to ensure the proper fermentation of cacao beans. A simple adoption of the greenhouse or solar propagation principle enables sunlight to be used for heating the mass of fermenting beans.

Design and Construction of the Solar Fermenting Frame.

The first experimental frame constructed on this principle consists of a double-walled, double-bottomed wooden frame or cabinet of external measurements, 6 ft. by 4 ft. by 4 ft., a three-inch air space being left all round between the inner and outer walls. The air space may be packed with straw to provide more efficient insulation. The frame is painted black, inside and outside. It is provided with a closely-fitting moveable, glass-paned cover. Two wooden planks, fixed on edge along the bottom of the frame, support separate moveable sweat boxes at a height of eight inches above the bottom of the frame. Two sizes of sweat box were made, (*a*) 1 ft. by 1 ft. by 1 ft. holding 40 lb. of wet cacao, and (*b*) 1 ft. by 1 ft. by 1½ ft., holding 60 lb. of wet cacao. The individual sweat boxes are provided with a lid or inverted box, which fits over and completely encloses the sweat box, leaving a space of half-an-inch between box and lid. The bottom and sides of the sweat boxes are perforated in order to provide aeration and drainage, but the top only of the lid is perforated. Boxes and lids are painted black on the outside only.

In theory, the solar frame should provide ideal conditions for the fermentation of small quantities of cacao. The sun's rays pass through the glass cover and are absorbed by the blackened walls and floor of the frame; the black surface becomes heated and warms the air in contact with it, thus producing an envelope of hot air which is retained by the glass cover and completely surrounds the small sweat boxes supported in the centre of the frame. Cacao treated by this method is thus cured by a combination of natural fermentation and artificial heat treatment.

Methods of Using the Solar Fermenting Frame.

The cacao beans are placed in the small sweat boxes, enclosed in the frame and allowed to ferment in the normal manner, but the envelope of hot air surrounding the sweat boxes prevents the escape of heat produced by fermentation, and some heat is actually supplied by the sun to the fermenting beans during the hottest hours of the day. The sweat boxes should be well lined with banana leaves before putting in the wet beans and the top of the sweat box should be covered with banana leaves before putting on the lid. This lining of banana leaves helps to prevent evaporation, and serves as an additional insulation against the loss of heat during the cooler hours of the night.

Prevention of Evaporation.

In order to prevent excessive drying out of the small mass of cacao, the air inside the frame may be kept damp by placing wet sacking on the floor of the frame. The following arrangement for maintaining humidity was found to work very well in practice:—wet sacking was placed on the floor of the frame and a kerosene tin (painted black) full of water was placed at each end of the frame with a piece of sacking dipping into the water and hanging over the side of each tin. This wick-like arrangement served to maintain the humidity of the air inside the frame for several days without any attention. *The above precautions for maintaining a humid atmosphere inside the frame are an essential feature of the process.* Unless these precautions are taken, the small mass of cacao will tend to dry out before fermentation is complete, and the final product obtained will be of very poor quality.

If it is required to open the frame at any time during the fermentation period, either to inspect the fermenting cacao, or to renew the water supply, the glass cover should only be removed early in the morning within one or two hours of sunrise. At this time of day the temperature of the air inside the frame is only slightly higher than the temperature of the outside air, and the loss of heat due to the removal of the cover is negligible.

Time Required for Complete Fermentation.

The length of the fermentation period will vary with different types of cacao. The right time to take the beans out of the frame can be determined by noting their appearance in the sweat box. Preliminary trials have shown that the best quality product was obtained from the solar fermenting frame when fermentation was allowed to proceed for *three days longer* than the normal period for the same type of cacao fermented in large batches under estate conditions.

III. Results of Fermentation Trials.

TEMPERATURE AND HUMIDITY CONDITIONS INSIDE THE SOLAR FERMENTING FRAME.

Records show that the air inside the solar frame has an average temperature throughout the 24 hours 33°F. higher than that of the outside air. When no precautions were taken to maintain humidity, the air inside the frame became very dry, and the rate of evaporation was greater than that in the outside air. When precautions were taken to maintain humidity (by means of wet sacking, &c.) the air inside the frame remained very humid throughout the 24 hours, and the average rate of evaporation was only 50 per cent. of that in the outside air. Cacao fermenting inside the solar frame attained maximum temperatures of 121°F. to 124°F. Similar small quantities of cacao fermenting outside, under ordinary favourable conditions, attained maximum temperatures of 108°F. to 111°F. During the fermentation period the temperature conditions throughout the mass inside the solar frame are very regular and even, the mean temperature of the edges of the mass being the same as the mean temperature of the centre. In a small mass of cacao fermenting outside under ordinary atmospheric conditions, much lower temperatures were recorded in the surface layers than in the centre.

COMPARATIVE APPEARANCE AND VALUE OF CACAO FERMENTED IN THE SOLAR FRAME.

In order to obtain an independent and completely unbiased estimate of the relative commercial value of the different final cacao samples, they were submitted for criticism and valuation to a large firm of cacao dealers in Port-of-Spain. A sample of cacao beans from the same picking, sweated and dried under estate conditions, was also submitted at the same time for comparative purposes.

The dealers reports showed that small lots of 40 lb. to 60 lb. wet cacao could be successfully fermented in a wooden sweat box enclosed in the solar fermenting frame. The final product of 15 lb. to 23 lb. dried, cured cacao beans was better fermented, had a better external and internal appearance, and a higher value on the local market than cacao fermented in large batches (2,000 lb. to 4,000 lb. wet weight) under the ordinary estate conditions obtained in Trinidad. The solar fermenting frame seemed to be very effective in producing an *even fermentation* throughout this small mass of cacao. The surface layers were free from mould, and as well fermented as the central portion. This is in direct contrast to the results obtained with small lots of cacao fermented under ordinary conditions. The low value of these samples was largely due to the inferior quality of the surface layers, which either became mouldy or dried and shrivelled during the fermentation process.

IV. General Conclusions: Possible Practical Applications of the Solar Fermenting Frame.

The practical results of preliminary experiments with the new solar fermenting frame have greatly exceeded expectations. Maximum temperatures attained during fermentation inside the frame were 7°F. to 12°F. higher than the maximum temperatures attained by a similar small mass of cacao fermenting under ordinary favourable conditions outside the frame. The final product obtained from the fermentation of 40 lb. to 60 lb. wet cacao was superior in appearance and value on the local market to estate cacao fermented in lots of 2,000 lb. to 4,000 lb. One of the most promising features of the method is that it ensures an *even fermentation* in a small mass of cacao. The surface layers are free from mould and as well fermented as the central portion, even though no turning was carried out, the mass being left undisturbed during the whole period of fermentation. Temperature records show that the mean temperature of the surface layers of the mass is the same as the mean temperature of the centre. Such even temperature distribution evidently eliminates the necessity for periodic turning, and ensures an even fermentation. With a small mass of cacao fermenting under ordinary conditions, much lower temperatures are recorded in the surface layers than in the centre, and frequent mixing or turning is therefore essential if an even fermentation is to be obtained.

The final quality of any cacao is the net result of variety or breed *plus* the treatment it receives in preparation for the market. It cannot be claimed therefore that improvement in fermentation methods could result in making the lower quality Forastero types of, say, the Gold Coast equal in quality to the Criollo or near-Criollo types of Venezuela or Ceylon. Nevertheless, it is the lower quality Forastero and Calabacillo types which stand most in need of proper fermentation in order to mitigate their harsher characteristics. The higher quality Criollo types can be fermented for a short period only if they are to retain their characteristic flavour and aroma. The Criollo type of cacao however, forms only a very small percentage of present world production. Approximately two-thirds of the total cacao crop of the world is low quality Forastero cacao produced by peasant proprietors, and this enormous quantity of cacao (about 350,000 tons annually) has all the faults of cacao fermented in separate small quantities.

The solar fermenting frame seems definitely to provide a method whereby very small quantities of cacao can be successfully fermented, so that the final product has all the characteristic appearances of the best estate fermented cacao. The new method would enable the peasant, no matter how small his property, to pick only ripe cacao for fermentation. There would no longer be the same incentive to include unripe and overripe cacao in an endeavour to increase the bulk available for fermentation. This factor alone should result in a great improvement in the quality of peasants' cacao. In the present preliminary stage of these investigations, however, it is not possible to state definitely whether the method is economically feasible or worth while to the small holder. As far as capital and current

expenditure is concerned, the new method seems to be much superior to other semi-artificial methods hitherto suggested for the curing of cacao, but the cost of construction of the fermenting frame used in these first experiments is probably still somewhat beyond the means of the small holder to whom the method should particularly appeal. The essential features of the apparatus are a black absorbing surface and a glass-paned cover whereby the heat energy of tropical sunlight is trapped and utilised to warm the fermenting mass of cacao. Further experiments are contemplated utilising these principles, but constructing the frame in the simplest and cheapest manner. There are a number of other points which still remain to be tested. For instance, Dr. A. W. Knapp, Chief Research Chemist of Messrs. Cadburys, Ltd., has shown that cacao beans cured by artificial heat processes were deficient in flavour and aroma after roasting, and it is possible that cacao fermented in the solar frame may have some such defect. Future experimental samples should therefore be submitted to chocolate manufacturers for their criticism.

Before this method can be used by the small holder a number of practical difficulties remain to be overcome. The peasant will have to be persuaded to pick only ripe cacao for fermentation ; this will involve more frequent pickings which will be more costly and more troublesome. Again, proper drying as well as proper fermentation will have to be carried out if a good quality final product is to be obtained. Finally, some system must be evolved by which the peasant who takes the trouble to produce well fermented cacao will receive some price premium over his neighbour. According to a report by Professor C. Y. Shephard on his recent visit to the Gold Coast, no marked improvement in the preparation of cacao in this Colony is likely to occur until price discrimination is introduced. At present no premium is received by individual farmers who take great care in the preparation of their cacao because improved lots of cacao are too small to be recognised by merchants who handle thousands of tons.

The preliminary trials so far carried out with the solar fermenting frame are purely experimental, and serve merely to draw attention to the possibilities of the method, which, in view of the important practical considerations involved, may be thought worthy of trial by agricultural officers, who are in a position to decide the possibility of overcoming the above practical difficulties.

VI. Summary.

(1) A new method of fermenting separate small quantities of cacao is described. Details of the new method and preliminary fermentation experiments are fully described in an article to appear in the Fifth Annual Report on Cacao Research. The present article is a brief review of this paper, and stresses the practical applications of the solar fermenting frame as a possible solution of the fermentation problems of small holders.

(2) The bulk of the world's cacao crop is low quality Forastero or Calabacillo cacao produced by peasant proprietors, and this very large total amount of cacao has all the characteristic faults of cacao fermented without special precautions in separate small quantities.

(3) The solar fermenting frame provides a method by which very small quantities of cacao (40 lb. to 60 lb. wet weight) may be successfully fermented, so that the final product has all the characteristic appearances of the best estate fermented cacao.

(4) The solar fermenting frame is cheap and easy to construct and costs practically nothing to use and maintain.

(5) The practical results of preliminary trials have greatly exceeded expectation, and this new fermentation method seems to be worthy of extended trials by agricultural officers who are in a position to decide the practical possibility of the solar frame, or of some simple modification of it.

RÔLE OF ORGANIC MATTER IN PLANT NUTRITION.

Continuing the series of researches on the above subject, three further papers by Subrahmanyan and his associates have appeared (*Proc. Ind. Acad. Sci.*, 1, No. 12). These deal respectively with the economy of carbon during decomposition of cane molasses in swamp soil, the influence of fermentable organic matter on the transformation of iron, and the relation of the oxidation of organic matter in the soil to plant assimilation. Addition of molasses to water-logged soil was accompanied by much loss of carbon in gaseous forms, and still greater loss occurred after flooding. The distribution of total carbon was not appreciably affected by the concentration of molasses. Flooding removed the bulk of the organic matter in all cases. Fermentation and loss of carbon were increased by increase of temperature and access of oxygen. It is suggested that in the growing of rice it would be advantageous to convert the bulk of the added organic matter to insoluble forms before flooding. Addition of fermentable organic matter to swamp soils brought quantities of ferrous iron into solution, the amount varying with different soils, whilst insoluble ferrous iron in the soil sediment increased in all cases. Increasing concentration of organic matter increased the amount of ferrous iron brought into solution, and solution and subsequent precipitation were hastened by rise of temperature to 45°C. Evidence is presented to show that ferrous iron in solution is largely present in association with organic acids produced during fermentation, whilst insoluble ferrous iron is present as carbonate and sulphide. A survey of tropical soils showed most of them to be poor in organic carbon, compared with soils from temperate regions. Addition of minerals may increase or depress the beneficial effect of organic manuring.—(*Nature* Vol. CXXXVI, No. 3448, p. 876, 1935.)

TOMATO CULTIVATION IN THE BAHAMAS.

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(*Lately Agricultural Instructor, Agricultural and Marine Products Board, Bahamas*).

[*The following short synopsis of the tomato industry in the Bahamas should be of interest to readers of this Journal; especially so to West Indian readers because of the endeavours in recent years to promote vegetable cultivation in several of the West Indian Islands.*]

Introduction.

In the Bahamas the soil conditions and methods of cultivation used in the tomato industry are unique for the cultivation of any economic crop and these have much to do with the success of the industry. Land is plentiful, so no effort is made to conserve it. Cultivation methods are extensive in the broadest sense of the word and, because of this, production costs are kept extremely low. The peculiar soil formation and climatic conditions have much to do with the fine quality and high yield of fruit produced.

To-day tomatoes are the main agricultural export from the Bahamas. This industry has been built up within the last 25 years. During the post war years, that is the boom years in the United States, the tomato industry was a very remunerative one because the New York market was then open and could absorb all the crop at high prices. Since the closing of this market by the imposition of a three cents per lb. duty by the United States of America in 1929, Canada has been the only market for Bahamian tomatoes. The demand in Canada is limited and the market is liable to be flooded at the height of the shipping season. At least this was the case during the seasons 1931-32, 1932-33 and 1933-34. Conditions were distinctly better, however, in 1934-35.

Tomatoes are cultivated on the islands of New Providence, Eleuthera, Harbour Island and Cat Island. These Islands have led the way in the industry chiefly because of their proximity to Nassau—the port of call. Several other islands grow tomatoes but on a small scale. The chief drawback to the development of the industry on other islands is the uncertainty and lack of shipping facilities coupled with the present low demand for the product.

Soil Types.

The crop is grown on soil which, by the casual observer, would be put down as unfit for cultivation. At first glance it appears to consist of nothing but honeycombed rock; on closer examination, however, pockets of black organic soil can be seen between these rocks. The Bahamas islands are marine in origin and of comparatively recent formation being Aeolian limestone. This accounts for the shallowness of the soil. There are three main soil types—red loam or clay, sandy or white and black soils. The red soil is laterite in origin, similar to the red soils found in other parts of the tropics. The sandy soil is marine in origin, being wind or wave-born calcareous sands. The black soil is formed from decayed vegetable matter and occurs in holes and crevices between the calcareous rocks. On each of these tomatoes can be grown but in normal seasons the best results are obtained from the black rocky soils. Red and sandy soils have not got the same capacity for holding moisture as the black. The limiting factor in tomato yields in the Bahamas is the low rainfall during the growing season. Irrigation is not a practical proposition on a large scale as it is in the Canary Islands and Southern Mediterranean countries. Firstly the soils in the Bahamas are very shallow and, in the case of the black soils, it does not pay to work them for more than two years. The installation of an irrigation system would thus be too expensive. Secondly the water, which must be obtained from wells, is very often saline and incapable of supporting plant life. The presence of so many rocks in the black soils makes mechanical tillage impossible. All tillage has to be done by hand. The rocks have great advantages, however, as they absorb moisture, somewhat like a sponge, and gradually give it back to the plants during the dry season. They also form a natural mulch keeping the ground cool and giving the fruit a clear and attractive appearance.

Varieties.

To-day only one variety of tomato is cultivated for the Canadian market, namely the Globe. This variety has been improved by rigid selection within recent years until it has reached a very high state of perfection as regards yield, quality and carrying powers.

Preparation of Land.

Preparation for planting begins in July when the low growing bush is cut down, allowed to wither and burned. This is undoubtedly a very wasteful and primitive practice but in view of the nature of the land, it is difficult to see how it can be cleared at a reasonable figure by any other method. Burning should be done after rains as soon as the top layer has dried out sufficiently. By so doing only the top layer is destroyed leaving the decayed vegetable matter untouched. By burning many of the harmful insects are destroyed and this is undoubtedly the reason why there is so little trouble from insect pests. Tomatoes are seldom grown more than two consecutive years on the same land because

then the land becomes exhausted and it does not pay to work it. It is allowed to grow back in wild vegetation and worked again in about seven years.

Planting.

After the land has been cleared, holes are dug in suitable spots. The soil in these holes is mixed with cave earth or fertiliser. Cave earth is an organic manure and, in its best form, is composed of bat droppings and decayed vegetable matter. It is obtained from cave holes on many of the Out Islands. Cave earth is preferable to commercial fertiliser for the seedling stage because it keeps the ground cool and does not force the young plants too much. If rains permit, the first seeds are sown about the 15th of August and sowing continues at varying intervals until the beginning of December. A considerable amount of trouble is usually experienced with the early crop because the ground is still warm and rains are uncertain Seeds sown in August should give tomatoes for the November market when prices are usually high. To-day fewer plants are sown in seed beds than formerly. Now the prevailing practice is to sow the seeds in holes which have been manured and to transplant the seedlings to adjoining holes as soon as they are strong enough and weather permits. There is one drawback to this system — it makes insect control in the seedling stage very difficult. The next stage in the cultivation is called " ringing ". This consists in a second application of fertiliser to the plants when they are from eight to ten weeks old. The second application of fertiliser brings the plants to the fruiting stage. For " ringing ", commercial fertiliser is used as now the aim is to force the plants. As mentioned above costs of production are kept very low. No endeavour is made to increase the yield by any intensive methods such as pruning or staking. Staking is unprofitable in the Bahamas owing to the rocky nature of the land and the high winds to which these islands are exposed during the months of September, October, November and December.

Fertilisers.

The most popular fertiliser is a 5 : 7 : 5 ($N : P_2O_5 : K_2O$) fertiliser which is derived from dissolved bone, nitrate of soda, sulphate of ammonia, cotton seed meal, H. G. tankage and German sulphate of potash. It has been built up by American chemists after a careful analysis of the soil. When cave earth is used in the seedling stage about 500 lbs. of commercial fertiliser is used per acre ; where no cave earth is used as much as 800 to 900 lbs. of commercial fertiliser may be used for the two dressings. Most small farmers use a considerable amount of cave earth, as much as 800 lbs. per acre with 400 to 500 lbs. of fertiliser. The larger farmers use commercial fertiliser chiefly because it is less bulky and easier to handle.

Pests.

Comparatively little trouble is experienced with insects. In the seedling stage cutworms and flea beetles may, on occasion, give trouble but are easily kept under control, when the seedlings are raised in seed beds. The Horn Worm *Protoparce sexta* does damage to the foliage but seldom on a large scale. The fruit worm, *Chloridea obsoleta*, and the green bug *Nezara viridula* do considerable damage to the fruit. *C. obsoleta* eats into the fruit and destroys its market value. The green bug punctures the skin and, by sucking the sap, leaves hard, corky areas which give the fruit an unpleasant appearance as it ripens. The punctures made by this bug open the way for bacterial rot.

Harvesting.

The tomato harvest begins in November and continues until the end of March. For the export market the fruit is cut when it is full and just before it begins to turn colour. Yields vary according to the season and the amount of fertiliser used ; a good average would be 150 30-lb. crates per acre of marketable tomatoes.

The tomatoes are taken from the field to the packing houses where they are culled, graded and packed. All packing houses are certified by the Board of Agriculture. Most tomatoes are now packed in Mexican 30-lb. lugs ; a few are packed in British Columbian 20-lb. lugs known locally as " flats ". The grades packed are those recommended at the Jamaican Fruit and Vegetable Conference, 1933, and have been in force in the Bahamas for several years. The fruit is brought to Nassau on small out-island boats and transferred to the C. N. S. steamers at the dock. All consignments are subject to inspection on the dock and, if rejected, may be repacked in the Board of Agriculture's Packing House at the shippers' expense. Any packing house which consistently puts up an inferior pack may have its packing house license withdrawn.

The export of tomatoes has decreased considerably since the closing of the New York market. This is due to the lower demand in Canada, now the sole outlet for Bahamian tomatoes. During the months of December, January and February the Bahamas are practically the only suppliers of tomatoes to Canada, and, with the present tariff agreements, they are likely to remain so because they are, comparatively speaking, near the Canadian market. They can produce a good quality tomato at a low cost and have an ample supply of land suitable for tomato cultivation.

Stricter supervision is required both in grading and packing if the optimum results are to be obtained and the increasing competition from the other West Indian Islands withstood. Adequate supervision is well nigh impossible since the Bahamas islands are very scattered with a correspondingly large number of small packing houses. Centralised packing houses have been suggested but, as they would certainly increase haulage costs, it is unlikely that they will ever be developed.

THE DEVELOPMENT OF CALVES IN THE TROPICS.*

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Introduction.

It is recognised that the rearing of calves in warm climates becomes increasingly difficult when high grade or pure-breds of the improved imported breeds are used.

The College dairy herd of more than 60 head is made up of cross-bred Holstein-Zebu and some 20 head of pure-bred Friesians. In this herd the serious problem of mortality in calves has been satisfactorily solved by proper hygienic methods. The authors had observed, however, that the development of the pure-bred Holstein calves was normal only up to about the sixth month. After this age a retardment in the rate of growth was noted as compared with calves of the same breed in its native environment.

Hammond[1] describing the degeneration changes of European cattle in Jamaica states "As far as could be judged, these changes appeared at about six months old when the calf was weaned. The younger calves suckling their dams appeared to look well and promising". The same phenomenon has been observed at the Inspectories Regionais do Fomento da Producao Animal de Pedro Leopoldo and at Pinheiros (Minas Gerais) where the herds are likewise managed on modern lines[2, 3, 4].

This decrease in rate of growth even under scientific care has resulted in a decrease of 11 to 13 per cent.[5] in the adult weight of the first native born generation of pure-bred as compared with the original imported adults.

It is generally true that the larger breeds of cattle come from regions of abundant food and that the smaller breeds have originated in countries less favoured in this respect. It is also recognised that when a breed is taken from a poor to a rich region or *vice versa*, it increases or decreases in size with succeeding generations. This occurs when the large European breeds are transported to the warm climates where there is an abundance of forage during the rainy season but a shortage during the dry season. The Tropics are also characterized by lack of forage rich in protein and, in some regions, by a lack of minerals essential for full growth. In addition, cattle suffer in the warm climates from the influence of factors other than nutritional. The object of this study was to measure the influence of some of these other environmental factors.

Animals used in the Experiment.

In this experiment 103 calves were used in the weight analysis at various ages. Of these 20 were cross-bred Holstein-Zebu of various degrees of crossing (16 females and four males) and eight pure-bred Holsteins (five females and four males) from imported cows and dropped at the College during 1931-32-33. Included also in the experiment were 15 pure-bred Holstein calves (six females and nine males), and 26 female and 34 male pure-bred Brown Swiss calves of the Inspectoria in Pedro Leopoldo.

Breeding Methods adopted at the E.S.A.V.

Breeding and rearing methods are effectively controlled so that accurate records were obtained. All calves are taken from their dams immediately after birth, weighed, treated and then placed in individual boxes. During the first week the calf receives colostrum three times daily. After the second week milk from the general herd is used. Apart from whole and skim milk, given heated, the calves are fed after the fourth week on a grain mixture of three parts wheat bran, two parts corn meal, half part oil meal or soya meal to which is added one to two per cent. of bone meal and one per cent. of common salt. The calves are put out to pasture during the day.

The calves are weighed weekly up to the 26th week and the quantity of milk to be given for the following week calculated on a sliding scale based on $\frac{\textit{liveweight}}{8}$.

Calf Feeding Table.

Age in weeks.	Live weight kgs.	$\frac{\textit{Live weight}}{8}$	Whole milk kgs.	Skim milk kgs.
1 ..	35	4.3	col.	—
2 ..	40	5.0	5.0	—
3 ..	44	5.5	5.5	
4 ..	49	6.1	5.6	5.0
5 ..	51	6.3	5.3	1.0
6 ..	55	6.8	4.8	2 0
7 ..	59	7.3	4.3	3.0
8 ..	64	8.0	4.0	4.0
9 ..	70	8.7	3.7	5.0
10 ..	76	—	3.0	6.0
11 ..	82	—	2.0	7.0
12 ..	90	—	1.0	8.0
13-17 ..	120	—	—	9.0
18-22 ..	140	—	—	8.0
23 ..	145	—	—	7.0
24 ..	150	—	—	6.0
25 ..	155	—	—	5.0
26 ..	160	—	—	4.0

* Estudo Sobre o Desenvolvimento de Bezzerros, *Bolitin de Agric., Zootechnia e Veternaria*; Anno VIII, No. 6, Junho 1935, pp. 327-336. Translated from the Spanish by A. O. Rhoad.

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After weaning at six months the calves are placed on pasture, supplemented with salt, bone meal, and a grain mixture. During the dry season they also receive corn silage. The calves are constantly under observation, are vaccinated against black leg, dipped every 15 days, treated for "berne" and are weighed each month. Each pasture is provided with a thatched shelter where the calves may protect themselves from rain and sun.

Feeding Methods at the Pedro Leopoldo Station.

The calves are fed artificially as follows :—

From 1 to 5 days,	3 times daily	—1.00 kgm. of milk.
,, 6 ,, 7	,, twice	,, ...1.50 ,,
,, 8 ,, 9	,, ,,	,, ...1.75 ,,
,, 10 ,, 11	,, ,,	,, ...2.00 ,,
,, 12 ,, 13	,, ,,	,, ...2.25 ,,
,, 14 ,, 15	,, ,,	,, ...2.50 ,,
,, 16 ,, 17	,, ,,	,, ...2.75 ,,
,, 18th day on	,,	,, ...3.00 ,,

They receive whole milk (6 kgs. per day) for the first two months and during the third month 3 kgs. of whole and 3 of skim milk. For the fourth, fifth and sixth months—6 kgs. of skim milk per day. Until two months old they are grazed five hours per day, after which they are on pasture day and night. With regard to concentrates, from the fourth to the fifth week they get, *ad lib.*, a mixture of equal parts of cotton seed and maize meal. From the third to the twelfth month—.50 to 1.00 kgm. of cotton seed meal and the same in corn meal in accordance with pasture conditions. During the drought some hay is fed.

A mineral mixture made up of bone meal—50 kgs., $CaCo_3$—30 kgs., NaCl—20 kgs., KI—20 gms. is given to the calves daily, 30 gms. for three to six months and 50 gms. from the seventh to the twelfth month. Weights are taken monthly.

Table I.

Growth in Weight of p.b. Holstein at Vicosa.

Age.	Mean kgs.	S.D. kgs.	C.V.
Birth ..	34.5±1.6	6.6±1.1	19.2±3.3
3 months ..	93.8±2.6	11.0±1.8	11.7±1.9
6 ,, ..	144.7±4.1	17.3±2.9	12.0±2.0
9 ,, ..	182.5±6.5	27.3±4.6	15.0±2.5
12 ,, ..	218.7±7.7	32.3±5.4	14.7±2.5

Table 2.

Growth in Weight of p.b. Holstein Calves, Pedro Leopoldo.

Age.	Mean kgs.	S.D. kgs.	C.V.
Birth ..	32.9±0.7	4.3±0.5	13.1±1.6
3 months ..	82.0±2.5	14.4±1.7	17.6±2.2
6 ,, ..	140.0±3.2	18.8±2.3	13.4±1.6
9 ,, ..	184.4±2.9	16.8±2.0	9.1±1.1
12 ,, ..	222.4±3.2	18.4±2.3	8.4±1.0

Analysis of Data.

Biometrical methods for ungrouped data were employed using the formula cited by Barbosa Rodrigues[6], Davenport[7], and Reitz[8]. Analysis was made separately in accordance with the origin of the data, and "breed-graphs" were plotted using the (Eckles) curve of normal growth for comparison.

Results.

Tables 1, 2, 3 and 4 give the mean weight, standard deviation, coefficient of variability at birth, 3 months, 6 months, 9 months and 12 months with respective probable errors.

Fig. 1 shows the mean weight from birth to 12 months for normal Holstein, for pure-bred Holstein from Vicosa and for those from Pedro Leopoldo. Brown Swiss were also included as the mean weight of this breed is approximately the same as that for the Holstein.

It is observed that the cattle from imported stock is smaller than the normal for the breed, the result of subnormal development in early life. An examination of Fig. 1 shows that the mean weight at birth, compared with the normal for the breed, is low for the pure-bred Holsteins from Vicosa as well as for those from Pedro Leopoldo. This difference is not very great however. Notwithstanding lower weight at birth the calves developed at a normal rate until the fourth month when growth began to decline. This decline is accentuated after the sixth month. Thus while the normal, (Eckles[9]), brings the calves up to 253 kgs. at 12 months, the offspring of imported cows born in Minas Gerais, reach only 220 kgs. at the same age.

Table 3.

Growth in Weight of p.b. Swiss Males, Pedro Leopoldo.

Age.	Mean kgs.	S.D. kgs.	C.V.
Birth ..	36.8±0.7	6.0±0.4	16.5±1.3
3 months ..	76.9±1.9	17.0±1.3	22.0±1.8
6 ,, ..	126.0±2.7	24.9±1.9	19.1±1.6
9 ,, ..	165.2±3.7	29.2±2.3	18.2±1.5
12 ,, ..	206.7±3.6	31.5±2.5	15.2±1.2

Table 4.

Growth in Weight of p.b. Swiss Females, Pedro Leopoldo.

Age.	Mean kgs.	S.D. kgs.	C.V.
Birth ..	36.8±0.9	6.8±0.6	18.4±1.7
3 months ..	73.5±2.2	16.8±1.5	23.0±2.3
6 ,, ..	118.2±3.5	26.9±2.5	22.7±2.2
9 ,, ..	162.8±4.1	29.7±2.7	18.3±1.7
12 ,, ..	206.8±3.9	29.5±2.7	14.2±1.3

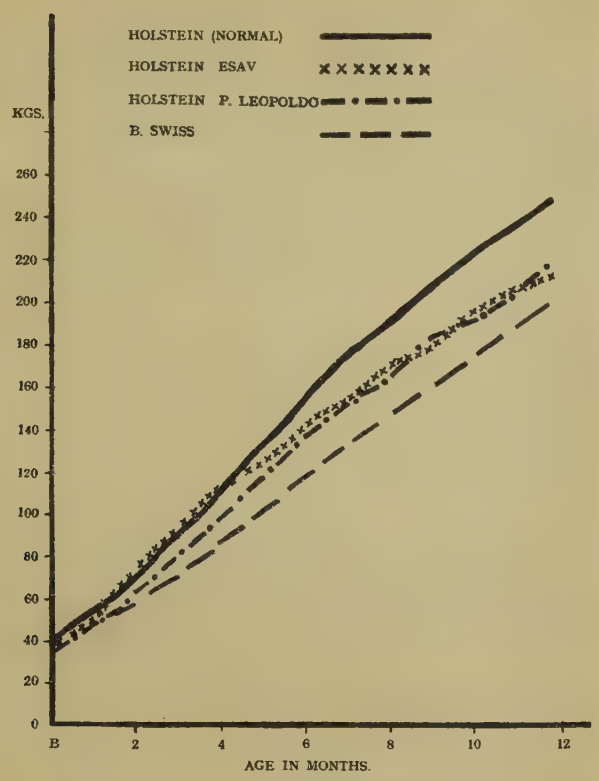

FIGURE 1.—*Growth in Weight of Native Purebred Calves.*

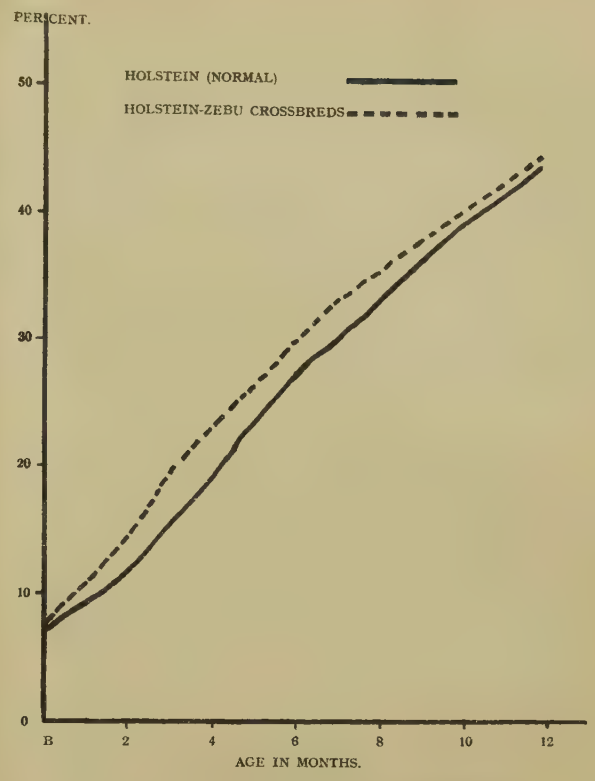

FIGURE 2.—*Growth of Calves in Relation to Weight of Adults.*

The Effect of Environment on Developments.

By the simple union of the gametes there is originated an impulse to grow which decreases in strength as the organism develops[10]. An animal is born with an inherent capacity to attain a determined size within a given age in accordance with the average weight of the breed to which it belongs and average weight of the parents. But the environment may greatly influence this power to grow by not furnishing the raw materials, especially proteins and minerals; by forcing the animal to expend energy for ends other than growth; by disease and also through lack of care on the part of the breeder.

By examining the feeding schedule it is seen that during the period of milk feeding there is no lack of nutrients while after weaning the supplementary ration supplies sufficient nutrients while on pasture. The amount of care given to the calves may be judged from the above and from the fact that both the authors personally supervised the herd.

The system of scientific calf rearing compares with that followed in other countries such as the United States. The data shows, however, that in warm climates such as is experienced in Minas, growth is not normal under this regime.

Table 5 gives the results obtained in the experiment on the cross-bred Holstein calves of the E.S.A.V.

Table 6 and Fig. 2 show the percentage of growth of calves in relation to the average live weight of their dams. The solid line represents normal growth (Eckles), in relation to adults and the broken line for the cross-bred.

Table 5.

Growth in Weight of Holstein-Zebu Cross-bred Calves.

Age.	Mean kgs.	S.D. kgs.	C.V.
Birth ..	32.2±0.7	5.0±0.5	15.7±1.6
3 months ..	88.2±1.2	8.3±0.8	9.4±1.1
6 ,, ..	134.5±2.1	13.9±1.5	10.3±1.1
9 ,, ..	169.1±3.2	21.5±2.3	12.7±1.3
12 ,, ..	198.9±4.1	27.2±2.9	13.7±1.4

Table 6.

Growth in Per cent. of Live Weight of Dams for Pure and Cross-breds.

Age.	Holstein normal.	Hol.-Zebu E.S.A.V.
Adult ..	565 kgs.	463 kgs.
Birth ..	7.2 per cent.	7.3 per cent.
1 month ..	9.7 ,,	11.0 ,,
2 months ..	12.5 ,,	15.1 ,,
3 ,, ..	16.1 ,,	20.1 ,,
4 ,, ..	20.0 ,,	23.6 ,,
5 ,, ..	24.2 ,,	27.0 ,,
6 ,, ..	27.9 ,,	31.4 ,,
7 ,, ..	31.5 ,,	33.9 ,,
8 ,, ..	34.1 ,,	36.4 ,,
9 ,, ..	37.5 ,,	38.7 ,,
10 ,, ..	40.1 ,,	41.2 ,,
11 ,, ..	42.4 ,,	43.3 ,,
12 ,, ..	44.7 ,,	45.6 ,,

The Development of Holstein and Zebu Cross-bred Calves.

Brody and Ragsdale[11] give seven per cent. of the weight of dam as the normal weight of calves at birth. This has been confirmed in this study with the cross-bred calves. Calculating the growth of the cross-breds at various ages it is found to be above normal in relation to weight of dams. This substantiates the statement that the method of feeding followed in this herd is adequate for normal growth and development and that the lack of development in native-bred pure-bred Holsteins is due to factors other than nutrition and general care.

Conclusions.

Pure-bred Holstein calves from imported dams show a decrease in the rate of growth relative to the normal growth of the breed. This growth check occurs from the fourth month on and is accentuated after the 6th month.

Environmental factors other than nutrition and care are responsible for the subnormal development.

Under similar conditions cross-bred calves develop normally.

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A SERIOUS PEST OF DATE PALMS, *OMMATISSUS BINOTATUS*, FIEB. (HOMOPTERA: TROPIDUCHIDAE.)

Introduction.

MUCH damage was caused last year to the date crop in Basrah, the largest and most important date-growing area in the world by the date bug. As the matter aroused and is still arousing much concern, not only in Basrah, but also in the 'Iraq, the following notes on this pest may be of interest.

Through the courtesy of Sir Guy Marshall, Mr. W. E. China kindly identified the bug as *Ommatissus binotatus*, Fieb., var. *libycus*, Berg., of the family *Tropiduchidae*. In 1922, Rao and Dutt* described a bug which they stated to be a new Fulgorid belonging to the *Cixiini* group. The description, however, coincided so closely with that of *O. binotatus*, that it has been assumed that it referred to the same pest. A. Alfieri† reported finding the bug at Siwa in Libya, the only record of its discovery outside of the 'Iraq.

If Rao and Dutt's description was that of *O. binotatus*, then it was reported, between 1919 and 1921, as common and rather serious in northern 'Iraq and as present in very small numbers in Basrah. Dutt was informed by Baghdad growers that attack by this bug had been serious some years previously. In Basrah, a few growers noticed typical symptoms of attack, though not the bug itself, in 1933. In 1934, a part of the district of Abu al-Khasib in Basrah, famous for its date gardens, was seriously attacked. Last year, probably few palms of the 7,000,000 in Basrah were entirely free. The writer who examined palms twenty miles apart through the most productive area found the bugs common while reports from other sources indicated that the attack covered the whole area. The heaviest infestation, however, was again in the Abu al-Khasib district. Here, in an area of perhaps 2,000 acres, the damage was very serious.

Life History.

The eggs, according to Alfieri (as quoted by the R.A.E.), " are laid singly, deeply embedded along the mid rib of the lower surface of the leaflets ". Those found by the writer in Basrah were always laid on the upper surface. They were whitish, sausage-shaped, more pointed at one end than at the other and about .25 mm. long. They were laid singly in nearly straight rows parallel with the long axis of the leaflet, each row containing from half a dozen to two dozen eggs. The egg rows were sometimes, but not always, along the mid-ribs of the leaflets. The writer has also found eggs on the under surface of leaflets. These were laid on the young leaflet apparently when it was still unopened as the egg-laying bug could not get between its two appressed halves to reach the inner, *i.e.* upper surface.

* *The Pests of the Date Palm in the 'Iraq*, Department of Agriculture, *Memoir No.* 6, Basrah, 1922.

† *Sur une nouvelle maladie du dattier*, Congr. int. Ent. Paris, 1932, 5, 2 Trav., Paris, 1933, as abstracted in *R.A.E., A.*, XXII, p. 190.

Alfieri states that the eggs are laid some time in, or after October, and hatch early in April. According to Rao and Dutt there are two broods, the eggs of the first being laid in October and November, and hatching in the following April and May, and those of the second being laid in June and July, and hatching in August and September. After hatching, the nymphs migrate to the fronds nearer the heart of the palm than those on which they were laid. Only rarely can nymphs or adults be found near their empty egg-shells. The nymphal skins can be found stuck to the inner surface of the leaflets in long rows.

The only specimens collected by the writer in 1934 were nymphs and adults on 11th June. In 1935, nymphs of all sizes were common on 25th April; but growers stated (and the state of the palms bore witness to the correctness of their statements), that symptoms of attack had been manifest some weeks before. The first adults of 1935 were seen on 21st May.

Symptoms of Attack.

The bugs exude honey-dew, hence the Arabic names for the pest, *Dubas* (honey-dew) and *Mann* (manna). A heavily infested palm may have as many as some thousands of bugs on each frond, especially on the new fronds near the heart of the palm while the fruit spikes may also be covered with the pest. When in large quantities, the bugs rapidly cover the fronds and fruit and much of the fibre and trunk with honey-dew. This ferments, and, where many palms are attacked, the neighbourhood may smell like a vinegar factory. The honey-dew is attacked by a fungus, and blackens, presumably with the spores of the fungus. The fronds wither, the spadices of the spikes of young dates give way, and instead of the spikes being nearly vertical, they hang limply. Why they should give way is not clear. Perhaps the puncture holes through which the bugs suck the palm sap may allow the entry of fungus. According to Alfieri, the fungus on the surface of the tissues causes their asphyxiation. It is said by growers that some palms heavily infested in 1934, died in 1935; and, judging by the state of some of the heavily infested palms in 1935 their statement is perfectly credible.

Damage.

In view of the lack of statistics available it is difficult to estimate the damage, although in 1935 this was believed to be in the region of over £80,000. What the damage to the palms themselves and consequently to future crops will be is even more difficult to estimate. It is certain it will be serious.

Methods of Control.

A dust made by the addition of 5 per cent. nicotine sulphate to finely powdered slaked lime, and a spray of ½ per cent. of nicotine sulphate in a ½ per cent. solution of yellow washing soap gives good control. A decoction of 1 lb. of tobacco in 44 gallons of the same soap solution is giving fair control. Thorough drenching with a large volume of water gives excellent control but the water must be applied with great force in order to knock the bugs down and bury them in the mud at the base of the palm. On the Kut as-Sayyid Estate, a 2 H.P. fire engine with a half-inch nozzle is being used on palms up to ten years old with excellent results, but for tall palms a much more powerful machine would be required. Merely washing the bugs off the fronds does little good, as unless they are killed, they crawl up the palm from the ground again.

Nicotine sulphate costs in Basrah from 2*s.* 11*d.* to 4*s.* 6*d.* a lb. Fifteen gallons of spray are needed to spray a palm thoroughly. For this, the cost of nicotine sulphate (at 3*s.* a lb.) is 6¾*d.*, of soap 2½*d.* and of labour ½*d.*, making a total cost of 9¾*d.* or about £4 1*s.* 3*d.* an acre. A power duster uses about 3 lb. of dust for each palm, so the cost of nicotine sulphate is about 5½*d.*, and for lime, about 1*d.*

The main difficulty in both spraying and dusting is making the insecticide reach the bugs. A date palm leaflet is doubled along its long axis, so that in transverse section it is V-shaped. At its point of insertion in the frond mid-rib, the two arms of the V meet completely; at the tip of the leaflet, the two arms open out wide; but it is close to the point of insertion of the leaflet into the frond mid-rib, where the two sides of the leaflet almost meet, that the bugs congregate in greatest numbers. The spray, to reach the bugs, must therefore fall from above downwards. It is no use hitting only the backs, or under surfaces, of the fronds from below as the bugs remain perfectly protected.

With a Headland sprayer working at a pressure of 200 lb. to the square inch (with variable spray lances 18 inches long), the only way to spray a tall palm is for a man to climb it, carrying the lance at the end of 50 feet of hose with him, work himself up through the spines into the fronds as far up as they will bear him, and spray, while his companion on the ground works the pump. Even in this way, however, it is difficult to get the spray into the narrow, up-turned, narrow V-s of the leaflets.

Dusting is also effective, provided the palm head can be covered completely. This, however, is also difficult with tall palms. The best results so far have been obtained with a power duster driven by a 3¼ H.P. engine, which the manufacturers state will throw a cloud of powder to a height of 60 to 100 feet. With the locally-made dust of hand-sifted lime and nicotine sulphate, however, the machine appears capable of effectively covering palms only of less than 30 feet in total height. Perhaps a more powerful machine, or a finer dust, would be effective for tall palms.

V. H. W. Dowson.

BEMISIA NIGERIENSIS CORB., A VECTOR OF CASSAVA MOSAIC IN SOUTHERN NIGERIA.

By F. D. Golding, M.A., F.R.E.S.

The writer recently recorded in this Journal (1) that he had obtained an indication that the Aleurodid, *Bemisia nigeriensis* Corb., can operate as a vector of Cassava Mosaic. In the present paper an account is given of further transmission experiments and of the incidence of *Bemisia* on different varieties of Cassava at Ibadan. Mr. J. West, a Botanist in the Nigerian Department of Agriculture, has obtained Cassava from various parts of Nigeria and from other countries in the hope of discovering a variety which is immune to Mosaic. The writer wishes to express his indebtedness to Mr. West for permitting him to study the incidence of *Bemisia* on these varieties and for providing him with cuttings for experimental purposes.

At a recent conference (6) various speakers were not in agreement as to whether *B. nigeriensis* is identical with *B. gossypiperda*, the vector of Leaf Curl of Cotton in the Sudan. If the two species are identical it is curious that *nigeriensis* has never been recorded from Cotton in Nigeria, where *B. goldingi* Corb., is the vector of Leaf Curl of Cotton (3, 4).

Transmission Experiment.

In the paper mentioned above (1) it was recorded that 814 adult *Bemisia* were collected from infected plants in the field and were introduced into a cage, containing two infected and two healthy plants, between 21st March and 8th April 1935. On 9th April, Mosaic symptoms were noticed on two young leaves of one of the healthy plants. On 15th April the second healthy plant showed evidence of infection. Mosaic did not appear on the leaves of either of the healthy plants in the control cage.

On 3rd August, 1935, two healthy cuttings of Bitter Cassava were planted in each of ten muslin cages. Table I shows the number of adult *Bemisia* (from mosaicked plants in the field) which were placed in the cages and the dates on which the introductions were made.

Table I.

Cage No.	No. of adults introduced.	Total No.	Date of introduction.
1	50	50	17th Sept. 1935.
3	97	100	18th ,,
	3		19th ,,
7	85	200	19th ,,
	115		20th ,,
11	192	400	21st ,,
	102		23rd ,,
	106		24th ,,
5	128	128	14th Oct.
9	150	380	15th ,,
	155		16th ,,
	75		17th ,,

Four cages were employed as controls.

On 4th October, one of the plants in cage No. 11 was found to be mosaicked and on 19th November the second plant in that cage showed signs of infection. The interval of over six weeks between the appearance of Mosaic symptoms on the two plants makes it seem reasonable to suppose that the virus was carried from the first to the second plant.

When the experiment was ended on 9th January, 1936, there was no sign of Mosaic on any of the plants in the four controls or in the remaining five experimental cages.

Hopkins (5), when carrying out transmission experiments with Aleurodidae on Tobacco growing in lamp chimneys, found that if a brown paper cap was placed on the top of the chimney the insects avoided the shade and settled on the leaves of the food-plant soon after the introduction was made.

The writer had noticed that when *B. nigeriensis* adults were placed in a cage many of them at once flew to the top. Adults enclosed in a vertical glass tube were found to remain at the upper end; when a paper cone was placed over the upper part of the tube they descended to the lower unshaded half of the tube.

On 9th November, 1935, one healthy cutting of Bitter Cassava was planted in each of seven lamp chimneys. Muslin was tied across the top of the chimneys.

Table II shows the number of adult white flies, from diseased plants in the field, which were placed in the chimneys on 19th November.

Table II.

Chimney No.	No. of adult Aleurodidae introduced.
2	54
5	26
6	15
7	64

Three chimneys were used as controls. After the white flies had been introduced into the four chimneys, brown paper caps were kept on all the chimneys (including controls) for 24 hours. The caps shaded the upper half of the chimneys. When the growth of the Cassava necessitated it, cylindrical extensions of thick celluloid were fitted onto the lower rim of the chimneys.

Mosaic appeared on the plants in chimneys five and seven on 16th December. When the experiment was ended on 9th January, 1936, there was no sign of Mosaic on the control plants or in chimneys 2 and 6.

These were the only transmission experiments in which positive results were obtained when the number of adults introduced was less than 400. In 1929 (2) the writer obtained negative results from eight transmission experiments in which from 50 to 55 adults were utilised in each cage. It seems possible that the positive results obtained with 26 and 64 adults in the chimneys were due to the shorter period which elapsed between the vectors having fed on diseased plants and on healthy plants. The paper caps caused the white flies to alight on the caged plants soon after they were introduced into the chimneys.

Four healthy plants of Bitter Cassava were grown in a muslin cage with a cubic capacity of 1.45 cubic metres. Adult white flies from diseased plants in the field were introduced into the cage on the following dates in November, 1935 :—130 on the 11th, 65 on the 12th, 134 on the 14th, 65 on the 15th, 140 on the 18th, and 72 on the 28th. A cover was placed on the top of the cage on 12th November, and was kept there throughout the experiment. On 2nd December, two plants showed signs of infection. On 9th January, 1936, the four plants were topped. Mosaic appeared on a third plant on January 30th, and on the remaining plant on 15th February. It is probable that the infection was carried from the first two plants to the two which first showed Mosaic symptoms in January and February.

Aleurodidae, thought to be *B. nigeriensis*, are not uncommon on the leaves of Ceara Rubber, *Manihot glaziovii*, and are occasionally found on the leaves of a small weed, *Euphorbia heterophylla*. Experiments in which adult *Bemisia* from diseased Cassava were introduced into cages containing either *M. glaziovii* or *E. heterophylla* gave negative results. On two occasions Ceara trees have been observed with their leaves showing a mosaicked condition apparently identical with Cassava Mosaic.

The Incidence of *B. nigeriensis* on Cassava.

The incidence of adult *Bemisia* was studied from 13th August, 1935, to 31st March, 1936, on 19 varieties of Cassava, planted by Mr. West in contiguous rows. When the first counts were made none of the plants of seven varieties was mosaicked, whilst those of seven other varieties were all infected.

The number of adult white flies on ten mature leaves of each variety was determined once a week. The most recently-matured leaves were selected as it was known that the adults are seldom found on the old leaves. The primary object of the counts was to afford a means of comparing the infestation of the various varieties.

Table III shows the number of adult *Bemisia* on ten leaves of each variety during 32 weeks. For convenience the results are shown in four-weekly periods, each being the sum of four counts.

Adult Infestation and Resistance to Mosaic.

A total of 50 or more adult *Bemisia* occurred on each of eight varieties; the percentage of plants mosaicked was 100, 100, 100, 100, 100, 100, 70 and 20. A total of 22 or less adult white flies was recorded on each of seven varieties;

Table III.

Serial No.	Variety.	Four Weeks Ending								Total.
		3rd Sept.	1st Oct.	29th Oct.	26th Nov.	24th Dec.	21st Jan.	18th Feb.	17th Mar.	
40	Owena	14	9	3	2	11	2	2	7	50
63	Benin	16	8	5	3	28	17	10	24	111
55	Sokoto	17	5	0	3	24	12	10	5	76
28	Onitsha	6	4	1	1	2	2	0	1	17
14	Umuahia..	7	1	2	2	21	16	9	9	67
19	Ibadan	3	5	0	1	1	1	1	0	12
30	Makurdi	6	16	0	0	8	11	0	1	42
31	Gold Coast	4	4	3	2	1	3	2	3	22
61	Ibadan	3	7	6	4	29	10	3	0	62
17	do.	13	4	0	0	12	1	0	1	31
48	Oshogbo	8	13	3	0	13	4	3	6	50
69	Sierra Leone	2	1	0	0	6	6	1	0	16
70	do.	2	3	0	1	6	6	3	0	21
72	Trinidad	2	3	2	4	27	14	7	6	65
73	do.	4	3	0	3	1	5	0	4	20
75	do.	1	0	1	1	6	5	0	1	15
76	do.	12	10	2	2	12	1	3	3	45
77	do.	6	3	2	0	9	8	2	1	31
13	Ilorin	21	4	2	1	18	25	6	5	82
	Total	147	103	32	30	235	149	62	77	835

the percentage of plants mosaicked was 14, 10, 10, 0, 0, 0 and 0. For the four varieties with an intermediate infestation (31 to 45 adult *Bemisia*) the Mosaic infection figures were 100, 89, 78 and 0 per cent. respectively.

It will be seen that, generally speaking, a high resistance to Mosaic was correlated with a light *Bemisia* infestation. It seemed possible that resistance to Mosaic was due to an unknown factor which rendered the variety repellent or unattractive to the insect vector. In order to test this possibility two cuttings were obtained from each of the five apparently completely resistant varieties and four from a highly susceptible variety. On 28th November, 1935, the 14 cuttings were planted in three rows in a large muslin cage; the four mosaicked plants formed the central row with five healthy plants on either side. Between 11th and 28th December, 1,802 adult *Bemisia* were collected from diseased plants in the field and were introduced into the cage. By 14th December, 399 adults had been placed in the cage and it was observed that only six were on the leaves of the ten resistant plants, whilst many were on the leaves of the four susceptible plants. The susceptible plants were shaken vigorously to disturb the white flies and, on the 16th, it was seen that the vectors were uniformly distributed over the 14 plants. All the plants were shaken almost daily for the next three weeks to ensure that some of the individuals which had been feeding on the mosaicked plants would move on to the resistant plants. Many immature *Bemisia* were seen on the leaves of all the plants during February and early March, 1936, and their distribution was uniform.

By 14th March, no sign of Mosaic had appeared on any of the ten resistant plants, which were then pruned right back. By 24th March, new leaves, all of which were healthy, had been produced.

From the results of these experiments it is concluded that the varieties of Cassava which did not develop Mosaic, owed their apparent immunity to an inherent resistance to the virus rather than to a repellent effect upon the Aleurodid vector. A light infestation of white flies is characteristic of most, but not all, of the Cassava varieties which are resistant to Mosaic.

In a paper (2) still in the press, the writer recorded, with reference to Ibadan varieties, that Sweet Cassava was more resistant than Bitter Cassava to Mosaic. The petioles of Ibadan Sweet Cassava are purple or purplish in colour and those of Ibadan Bitter Cassava are green. It is of interest to record that, of the 19 varieties being studied by Mr. West, the seven which are most resistant to Mosaic are all characterised by a deep purple colouration of the petiole. Of the ten varieties with from 70 to 100 per cent. Mosaic there are five with green petioles three with purple and two with purplish.

The Incidence of the Immature States of *B. nigerensis* on Different Varieties of Cassava.

The larvae and puparia of *B. nigeriensis* are invariably found on the lower surface of the leaves. The number of immature *Bemisia* on ten mature leaves of each variety of Cassava was determined on 12th November, 1935, and on 14th January, 1936, and was estimated (by a method which was found to give results within ten per cent. of the actual number) on 3rd and 10th September and on 8th and 29th October.

Table IV shows the estimated total number of immature *Bemisia* on ten leaves of each variety on the six dates mentioned above.

Table IV.

Variety.	Approx. No. of immature *Bemisia*.	Variety.	Approx. No. of immature *Bemisia*.
40. Owena ..	165	48. Oshogbo ..	153
63. Benin ..	184	69. Sierra Leone ..	46
55. Sokoto ..	149	70. do. ..	30
28. Onitsha ..	102	72. Trinidad ..	53
14. Umuahia ..	110	73. do. ..	47
19. Ibadan ..	93	75. do. ..	57
30. Makurdi ..	112	76. do. ..	71
31. Gold Coast..	152	77. do. ..	77
61. Ibadan ..	108	13. Ilorin ..	210
17. do. ..	79		

A comparison of the figures in Tables III and IV. shows that the average number of immature *Bemisia* was 141 for the eight varieties with an adult infestation of 50 or more, 85 for the four intermediate varieties and 75 for the seven varieties with 22 or less adults. With the exception of the four varieties, 19, 28, 31 and 72, there was close agreement between the incidence of adult and immature *Bemisia*. It is evident that the exotic Cassavas from Sierra Leone and Trinidad were less favoured by ovipositing females than the indigenous varieties and No. 31 Gold Coast.

The average number of immature white flies for the 11 indigenous varieties, was 142 on those with green petioles, 151 on those with purplish petioles, and 119 on those with purple petioles. For all varieties the corresponding figures were 129, 103 and 94 respectively.

The Bionomics of *B. nigeriensis*.

Breeding was continuous from early August, 1935, to the end of March, 1936. The number of immature *Bemisia* decreased gradually from early September to mid-November. There was an increase in mid-January, whilst, in March, there were fewer larvae and puparia than in any month during the period studied. No evidence was obtained that the immature stages of *B. nigeriensis* are attacked by either parasites or predators. Small spiders were the principal natural enemy of the adults.

Table V.

	Fortnight ending								
	20th Aug.	3rd Sept.	17th Sept.	1st Oct.	15th Oct.	29th Oct.	12th Nov.	26th Nov.	10th Dec.
No. of adults ..	99	48	70	33	21	11	10	20	103
	Fortnight ending								
	24th Dec.	7th Jan.	21st Jan.	4th Feb.	18th Feb.	3rd Mar.	17th Mar.	31st Mar.	
No. of adults ..	132	101	48	38	24	31	46	28	

Table V shows the total number of adults on the 19 varieties each fortnight throughout the period.

It will be remembered that the method of counting employed was designed with the object of providing comparative data on the incidence of the adults on the various varieties each week. During December and January the plants were producing very few new leaves with the result that the food supply was reduced and the adults became more concentrated in their distribution. There is no doubt that this is the explanation of the increase in numbers during December and early January. On 24th January, 1936, 1.07 inches of rain fell, and, a few days later, the plants produced many new shoots. On the other hand, it is certain that the decrease in adult infestation in October was not due to a diminution in the amount of available food. Atmospheric humidity was decreasing from September to January. The mean relative humidity at 3 p.m. was 74.3, 70.4, 66.5 and 54.2 per cent. for September, October, November and January respectively. There was, however, no evidence that the reduced humidity prevented the immature white flies from completing their development or that it had a lethal effect upon the adults. The heaviest rainfall on any day in the period was 1.77 inches on 20th October. 16 adults were counted on 15th October, and only two on the 22nd; this was the smallest number recorded in any of the 34 weeks. There were two other instances of a reduction in the adult infestation soon after exceptionally heavy showers of rain and it seems probable that the mechanical action of very heavy rain destroys many adults. The total rainfall for August, when adults were numerous, was only 2.06 inches and the heaviest fall on any one day was 0.54 inches.

Breeding was continuous throughout the period and it was not possible to determine the number of generations produced. From the available data it is thought that there was a generation once every four to five weeks. Recently-moulted adults were very numerous on 13th August and again on 10th September.

Summary and Conclusions.

(1) A series of transmission experiments with *Bemisia nigeriensis* Corb. adults, collected from mosaicked Cassava in the field and placed in cages containing healthy plants, proved that this species is a vector of Cassava Mosaic.

(2) Positive results were obtained in five out of 12 experiments. In one experiment 814 adults were introduced into a cage containing two healthy and two diseased plants; both the healthy plants developed Mosaic. In two other experiments 606 and 400 adults were placed in two cages containing four and two healthy plants respectively; all six plants became mosaicked. In the two other experiments 26 and 64 adults were introduced into lamp chimneys, each containing one healthy plant; both plants developed the disease.

(3) In two experiments Mosaic symptoms appeared 27 days after adult *Bemisia* had been placed in the chimneys. In the other three experiments the vectors were introduced on several days; the maximum intervals between the introduction of *Bemisia* and the first appearance of Mosaic symptoms were 13, 19 and 21 days respectively. The number of vectors utilised was much greater in the last three experiments than in the first two.

(4) Attempts to transmit Mosaic from Cassava to *Manihot glaziovii* and *Euphorbia heterophylla* gave negative results.

(5) The incidence of adult white flies on 19 varieties of Cassava was studied over a period of 34 weeks. It was found that varieties which showed resistance to Mosaic were almost invariably more lightly infested by *Bemisia* adults than were susceptible varieties.

(6) An experiment in which 1,802 adults were placed in a cage containing four susceptible mosaicked plants and ten resistant healthy plants (two of each of five varieties) did not result in the healthy plants becoming mosaicked. It was concluded that the varieties which did not develop Mosaic owed their apparent immunity to an inherent resistance to the virus rather than to a repellent effect upon the Aleurodid vector.

(7) It was noted that the seven varieties which were most resistant to Mosaic were characterised

by a purple colouration of the petiole. Of the ten most susceptible varieties five had green petioles and five purple or purplish petioles.

(8) Immature *Bemisia* were present on all varieties; but were less numerous on seven exotic varieties from Sierra Leone and Trinidad than on 11 indigenous varieties and on one Gold Coast Cassava. Except on four varieties there was close agreement between the incidence of adult and immature *Bemisia*.

(9) Breeding was continuous from 13th August, 1935, to 31st March, 1936. Evidence was obtained that the mechanical action of unusually heavy showers of rain destroys many adults. No parasites were found.

References.

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(2).....(1932).—Cassava Mosaic in Southern Nigeria. *11th Ann. Bull. Nigerian Agric. Dept.* (in press).

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(5) Hopkins, J. C. F. (1932).—Further notes on Leaf Curl of Tobacco in Southern Rhodesia *Rhod. Agric. Journ.*, Vol. 29, *No.* 9.

(6) Report of the Fourth Imperial Entomological Conference 19th to 27th September, 1935, p. 70.

GRAFTING AND BUDDING CACAO.*

By H. Burchardt.

The author gives an account of the successful change-over which is being made by the New Guinea Company in its cacao plantations at Bococo, Fernando Po, from Forastero to Criollo cacao by budding the former with the latter. The oldest existing trees so worked four years ago are now healthy, strong growing, and well furnished with fruit. So far from feeling any ill effects, the scions appear to have benefited from being worked on the stronger and hardier Forastero type. The method of budding which has been particularly successful in the case of three-year-old trees standing about 1½ metres high and with a diameter of 4 cm. is given below. Such a size is particularly suitable for a good take. Only such scion wood is used as has just achieved complete ripeness at nine months. The so-called water shoots which provide it have their buds on spirals. Their ripeness can be determined from the bark, which should have exchanged the down of youth for a rather rough and split condition. The time for budding depends on the weather, the best of all being an overcast but fine day following considerable rain. The operation is as follows:—a piece of bark some 6 to 8 cm. long is removed with a sharp knife from the shady side of the stem of the rootstock, about 20 cm. above ground level. During the passage of the knife through the cambial layer the separated bark shield should be pressed in tightly with the thumb. This prevents exposure of the delicate cambial layer to light and air. A bud is then cut of corresponding size, particular care being given to preserving the heart intact. The flap of bark is quickly removed and the bud applied immediately. It is bound with raffia and the edges of the wound covered with liquid grafting wax. In the moist tropical atmosphere a crust will soon form to prevent the entry of air and water. With the help of two natives it was found possible to do 80 to 100 buds in two hours. If after two to three weeks union has taken place, the Forastero stem is bent down to the ground where it is fastened by pegs or weighting, care being taken that the bud comes on the outside of the bend. In some cases the stem is too strong to bend right to the ground, but it should be so arranged that the lowest part of the stem is at least on a slant. The irritation caused by the bending causes an inflow of sap and nutrients to the injured spot. These stimulate all the dormant eyes including the new one into growth. The resulting Forastero growths are removed. When the Criollo shoot is 20 cm. long the top of the rootstock is removed, leaving only a 30 cm. stump to which the young shoot is bound until about six months from budding, when support should be no longer necessary and the stump can be entirely removed. This is best done with a saw and finished off with a pruning knife, the surface being then covered with wax. Such trees have so far begun to bear fruit at latest two years after budding. The same operation has been successfully carried out by the author in young Forastero nursery beds. This offers the advantage of easy supervision after budding, but a distinct disadvantage in the greater care necessary in transplanting the nursery worked trees. Where it is decided to work trees in the nursery, the rows should be 35 cm. apart and 20 cm. from plant to plant within the row. The seedling Forasteros are ready for grafting at 18 months when about a forefinger thick. The best time for budding in Fernando Po is towards the end of what is called the short rainy period, *i.e.*, May to June, in which case the trees should be ready for transplanting six to eight weeks later in August during the true rainy season. The technique adopted in planting out is as follows:—The leaves up to those immediately surrounding the terminal bud are removed. The roots are dipped into a loamy mulch and the trees are planted out in holes previously prepared. The author has sometimes left the worked trees standing a further year in the nursery before transplanting, in which case it has been necessary to cut the scion back to one-third of its length. All things considered he prefers budding in the permanent plantation. For budding older, *i.e.*, five- or six-year-old trees, the T cut method is recommended and has been successfully used at times when the sap is flowing strongly and the bark comes away well. At whatever period and wherever carried out, in the plantation just as much as in the nursery, it is essential to provide shade for the buds. For this in Fernando Po the Jamaica banana has proved very useful.—(*Horticultural Abstracts*, Abstract No. 699, Vol. V, No. 4, 1935.)

* Translated from article in *Tropenpflanzer*, 1935, 38: 239-45.

WEST INDIAN NOTES.

(*Compiled by the Advisory Department, Imperial College of Tropical Agriculture.*)

The Sugar Industry.

Reports from the sugar producing Islands do not indicate any important change in the crop estimates for 1936 published in the last series of notes. See *Tropical Agriculture* for April.

Measures for Control of *Diatraea saccharalis* in Antigua.

In April, 1936, Mr. H. E. Box, Entomologist, reported that the Amazon fly (*Metagonistylum minense*) had failed to become established in Antigua, and that there was no reason to expect that a repetition of the experimental introduction of this parasite would give other than similar results.

In consequence of the failure of the Amazon fly, Mr. Box recommended the early trial of the parasite *Paratheresia claripalpis* V. de W. But pending the introduction of and initiation of a breeding campaign with this parasite, he recommended the commercial utilization of the parasite *Lixophaga diatraeae*, not as a probable means of permanent control but as a palliative measure only.

Accordingly Mr. Box visited St. Kitts in April where he accumulated initial stocks of *Lixophaga*, and then proceeded to Antigua to inaugurate the new breeding campaign. The expenses of this breeding campaign are being borne by the Antigua Sugar Factory.

The British West Indies Central Sugar-Cane Breeding Station in Barbados.

The fifth meeting of the Advisory Committee was held in Barbados from 14th to 16th April, 1936. The following members of the Committee were present :—Mr. R. W. R. Miller, Director of Agriculture, Barbados, (Chairman) ; Sir Geoffrey Evans, Imperial College of Tropical Agriculture ; Mr. G. A. Jones, the Windward and Leeward Islands ; and the Hon. E. J. Wortley, Trinidad. The Hon. A. C. Barnes, Director of Agriculture, Jamaica, was unable to attend. The Geneticist of the Station, Dr. A. E. S. McIntosh ; the Assistant Director and Chemist, Dr. S. J. Saint and the Entomologist of the Barbados Department of Agriculture, Mr. R. W. E. Tucker also attended the meeting.

Some of the findings of the Committee are summarised below :—

Contributions to the upkeep of the Station from the Co-operating Colonies. In view of the fact that during the next financial year which begins on 1st October, 1936, the cost of upkeep of the Central Sugar-Cane Breeding Station will be borne to the extent of fifty per cent. by the different co-operating colonies as follows :—

	£	s.	d.
Trinidad	500	0	0
Jamaica	262	10	0
Leeward Islands	212	10	0
Windward Islands	25	0	0
	£1,000	0	0

the Committee recommend that the Barbados Government be asked to arrange for the collection of these contributions in half-yearly instalments in advance.

General Progress of the Breeding Work at the Station. The Advisory Committee have studied the experimental work both at Codrington Experimental Station and in the field and are satisfied that progress is being made according to plan.

The Distribution of Sugar-cane Seedlings. The Committee consider that in future when sugar-cane seedlings are ready for release from the Plant Quarantine Station the Central Sugar-Cane Breeding Station should be notified. The Chairman of the Advisory Committee, after consultation with the Geneticist of the Central Sugar-Cane Breeding Station, should thereupon notify the Secretary of the Plant Quarantine Station for which Islands the different seedlings are considered suitable for trial. He should also furnish the islands concerned with descriptive notes on each seedling for the guidance of the local Agricultural Departments in testing the seedlings.

The Committee consider that, as only in the rarest event do thick-cane sugar-cane varieties not specifically bred for British West Indian conditions succeed in the West Indies, it is not in the best interests of the sugar-cane industry of the British West Indies to introduce sugar-cane varieties of this type—other than those produced by the Central Sugar-Cane Breeding Station. Introductions of cane varieties in general, if any, should be made only after the most careful consideration of each case by the Agricultural Department concerned and each intended introduction should be notified to the Central Sugar-Cane Breeding Station together with the circumstances of the proposed introduction.

* * *

The Cotton Industry.

St. Vincent.

Abnormal dry weather shortened the crop and greatly reduced the yield from late planted cotton. The total crop, which was completed early in April, is estimated at 900 bales of 400 lb. each (360,000 lb.). This is the largest crop produced in St. Vincent since 1926.

Nevis.

Final figures for the crop in Nevis are not yet available, but the total crop is estimated at about 186,000 lb. lint.

Antigua.

The final estimate of the 1935-36 crop in Antigua was 350-360 bales of 300 lb. each (105,000 to 108,000 lb. lint).

ANGUILLA.

The final estimate for the 1935-36 crop in Anguilla amounts to 30,000 lb. lint.

BARBADOS.

A small area was again planted in Barbados in 1935-36 and the crop was in consequence small, amounting only to 9,594 lb. lint.

THE BRITISH VIRGIN ISLANDS.

The Sea Island cotton industry has been resuscitated on a small scale in the Virgin Islands and the final estimate of the first planting (1935-36) amounted to 200 bales of 250 lb. each (50,000 lb.). Unfortunately the crop in Virgin Gorda was completely ruined by pink bollworm.

MONTSERRAT AND ST. KITTS.

In these two Islands the cotton crop is usually planted in March. This year, however, owing to exceptionally dry weather considerable difficulty has been experienced in establishing the crop and it is feared that the ultimate size of the crop may be unfavourably influenced.

SEA ISLAND COTTON IN FIJI.

The extension of the Sea Island cotton industry in Fiji has been recently under consideration. The Government of Fiji has undertaken to restrict production to an annual quota of 300 bales of 400 lb. each for a period of five years (1937-41).

WEST INDIAN SEA ISLAND COTTON ASSOCIATION.

In accordance with the suggestion made by the Association at their third annual general meeting in January, 1936, the Advisory Committee in England have engaged the services of a whole-time officer to undertake the collective duties of Secretary to the Committee, of Trade Mark administration and of Market Intelligence Officer.

The Government of Trinidad and Tobago has introduced Customs' Regulations admitting free of duty the importation of cotton materials bearing the trade mark of the West Indian Sea Island Cotton Association intended for use in the local manufacture of shirts. This action is also the outcome of a resolution passed by the Association at their third annual general meeting.

At the end of March, 1936, certificates for the use of the trade mark had been granted to 58 applicants.

* * *

The Citrus Industry.

THE CITRUS WEEVIL.

An investigation of the citrus weevil problem in St. Lucia was made by Mr. R. G. Fennah, Lecturer in Entomology, in April. Mr. Fennah reported "There is no room for doubt from the number of observations made by Mr. H. E. Box, who devoted some time to the problem, the officers of the Department of Agriculture, the planters and the writer that the greater part of the damage to citrus must be due directly or indirectly to weevil attack".

The St. Lucia Agricultural Department has undertaken a series of experiments, designed by Mr. Fennah, to determine, if possible, a suitable and economical method of controlling the weevil. The experiments include three main lines of attack:—

(i) *Control by spraying the leaves.* The principle underlying this treatment is to render the foliage so distasteful as to drive the adult weevils on to their ubiquitous wild alternative host plants, in the hope that oviposition will largely take place on them, and larval infestation of citrus will be reduced.

(ii) *Control by the use of protective layers.* This treatment aims at preventing by mechanical means the larvae hatching on citrus foliage from reaching the roots.

(iii) *Control by the use of soil fumigants.* This treatment aims at destroying the larvae feeding on the roots.

Mr. Fennah has also given consideration to the possibility of establishing biological control, but in view of the slender chance of ultimate success by such means does not recommend expenditure on a project of this type at present.

In Montserrat, root disease of the lime has been reported* by Mr. R. E. D. Baker, Lecturer in Mycology, to be caused by the destructive activities of the citrus weevil (*Diaprepes* root borers). The problem of the control of the weevil in Montserrat is also being investigated by the Entomological Department of the College.

THE EXPORT OF GREEN LIMES.

The voluntary arrangement between the exporters of green limes in Dominica, St. Lucia and Trinidad for fixing the minimum f.o.b. price of green limes exported to the United States has been renewed for the present season between the exporters in Dominica and St. Lucia, but the exporters in Trinidad have decided to export on consignment. The exporters in Montserrat also continue to export on consignment.

The Government of Trinidad has introduced Regulations to govern the export of green limes in accordance with the recommendations of the West Indian Fruit and Vegetable Council (Eastern Group). These Regulations apply to the green limes exported during the present season.

* * *

The Banana Industry.

In Table 1 the quantity of bananas supplied by the various Island organizations to the Canadian Banana Co. for the first five months of 1935 and 1936 are set forth.

At the beginning of May, Dr. C. W. Wardlaw visited Dominica to investigate the present position with regard to Panama Disease and to estimate its possible influence on the development of the banana industry in that Island. Dr. Wardlaw reported favourably on the prospects of the industry provided certain precautions are taken immediately. He recommended the establishment of an adequate service of inspector-instructors to carry out disease control and

* *Tropical Agriculture*, Vol. XIII, No. 6, p. 147.

Table 1.

Bananas Exported to the Canadian Banana Company for the period January to May, 1935 and 1936.

	Trinidad.		Grenada.		*St. Vincent	St. Lucia.		Dominica.		Total.	
	1935.	1936.	1935.	1936.	1936.	1935.	1936.	1935.	1936.	1935.	1936.
Nines ..	6,667	18,945	2,217	16,661	2,048	1,968	6,290	3,950	6,999	14,802	50,943
Eights ..	6,808	19,980	2,214	13,192	3,212	2,695	7,800	4,734	7,644	16,451	51,828
Sevens ..	8,514	20,860	2,748	13,768	4,078	2,958	9,660	5,670	9,484	19,890	57,850
Sixes ..	—	160	1,263	3,764	1,216	492	2,740	858	940	2,613	8,820
Total Stems ..	21,989	59,945	8,442	47,385	10,554	8,113	26,490	15,212	25,067	53,756	169,441
Equivalent Counts ..	16,030	44,400	5,567	34,380	6,800	5,592½	17,764	10,550	17,704	37,739	121,048
Percentage Counts ..	73	74	66	72	64	69	67	69	70	70	71

* 1st shipment made in July, 1935.

Table 2.

Island.	1934.		1935.	
	Coconuts. Nos.	Copra. lb.	Coconuts. Nos.	Copra. lb.
St. Vincent	979,988	2,015,675	3,391,582	840,602
St. Lucia	2,616,175	676,544	2,814,965	483,220
Dominica	103,639	247,508	230,170	278,793
Antigua	400	—	2,300	—
Trinidad	9,850,299	17,928,775	5,491,240	8,764,646

instruction of peasants, and expressed the opinion that during the initial stages of development at least seven inspectors, four for the northern section and three for the southern section, would be required.

The Vegetable Industry.

The tomato industry in Montserrat has expanded considerably during the recent season. To the end of April 44,249 crates had been exported to Canada, and it was then estimated that the total crop exported would amount to approximately 50,000 crates. The corresponding figure for the season of 1935 was 14,051 crates.

The Coconut Industry.

The following table gives the exports of coconuts and copra for the years 1934 and 1935 :—

In addition, Trinidad exported 31,118 gallons of coconut oil in 1934 and 14,897 gallons in 1935.

* * *

Brevities.

Mr. G. A. Jones, Commissioner of Agriculture, visited St. Lucia and Dominica between 31st March and 12th April.

* * *

Mr. C. C. Skeete, Assistant Commissioner of Agriculture, visited St. Vincent from 18th March to 2nd April.

* * *

Mr. G. A. Jones, Commissioner of Agriculture, sailed for the United Kingdom on 22nd June on four months' leave.

Mr. H. E. Box, Entomologist, visited Trinidad from 1st to 9th March, and St. Kitts and Antigua from 21st April to 16th May.

* * *

Sir Geoffrey Evans, Principal, accompanied the post-graduate students on a short visit to St. Lucia leaving Trinidad on 31st March and returning on 8th April.

* * *

Mr. A. Wimbush, Chief Conservator of Forests, Madras, sailed for England on the 25th March, after completing his inspection of the forest conditions in the Windward and Leeward Islands.

Mr. R. E. D. Baker, Lecturer in Mycology, visited Montserrat from 17th March to 8th April to investigate and report on the diseases of the lime. His report was published in the previous issue of this Journal.

* * *

The Principal and the Commissioner of Agriculture attended a meeting of the Advisory Committee of the British West Indies Central Sugar-Cane Breeding Station in Barbados from 14th to 18th April.

* * *

Mr. R. G. Fennah, Lecturer in Entomology, visited St. Lucia from 31st March to 11th April, and Montserrat at the end of June to investigate the citrus weevil problem and make suggestions for the control of the weevil.

Mr. C. A. Gomez, Curator, Montserrat, has been transferred temporarily to Antigua in the capacity of "Specialist Officer". Mr. S. A. Schouten, Assistant Agricultural Officer, has been appointed to act as Curator during Mr. Gomez's absence.

* * *

Dr. C. W. Wardlaw, Officer-in-Charge of the Low Temperature Research Station, visited Dominica from 3rd to 7th of May to investigate the status of Panama disease of bananas in that Island and to make recommendations for its control.

* * *

Mr. F. H. S. Warneford, Agricultural Superintendent, Antigua, has been granted four months' leave from 2nd May. Mr. L. L. de Verteuil, Agricultural Assistant, has been appointed to act as Agricultural Superintendent during Mr. Warneford's absence.

REVIEWS.

WARNING FROM THE WEST INDIES.

A Tract for Africa and the Empire. By W. M. Macmillan, *Faber & Faber*, London, price 8*s*. 6*d*.

The title of Mr. Macmillan's book suggests that it deals with a subject of pressing concern to Africans and to those responsible for the organization and direction of African development but it would seem to be of more concern, at least in the present generation, to the inhabitants and to those responsible for the welfare of the inhabitants in the West Indies.

The subject of the book is, in general, the past and present condition of the masses of the people —the descendants of the slaves—in the British West Indies, their relation to the so-called dominant minorities, and the reconstruction and re-organization urgently required to achieve and maintain a better standard of living among the lower classes of the black inhabitants. The book is of especial interest from the agricultural point of view, for on agriculture and agriculture alone rests not only the future prosperity but almost the entire existence of the West Indies.

Mr. Macmillan apparently possesses only a superficial knowledge of the subject—the people, their psychology and customs, local conditions, &c.—and this has led to the expression of certain important misconceptions and to the omission from consideration of certain vital factors, but on the whole the case has been fairly reasonably stated and many useful arguments have been put forward which those concerned with the welfare and future of the Islands would do well to study carefully.

The author describes in brief the 'West Indian Scene'—the Islands, their social conditions, colour relationships, political and legal rights—and claims to show how Crown Colony rule has failed to carry its burden of responsibility for the unrepresented masses.

A chapter is devoted to a discussion on the health of the inhabitants, and a generally poor standard of health among the people is claimed, The relative effect of the climate on the Europeans, Creoles, and Blacks is outlined. The inadequacy and weakness of the arrangements for public sanitation are exposed, and housing conditions are described. The question of health is claimed to be greatly influenced by chronic diet-deficiency and malnutrition which are declared to be the two prime causes of low power of resistance to disease among the majority of the people. A significant fact is mentioned—"even if good feeding were available and understood, agricultural wages would not buy it". This has considerable bearing on future agricultural development and on the prosperity or otherwise of agricultural industry, for on the measure of prosperity the standard of wages depends.

Another chapter deals with various aspects of education in the West Indies. The usual reference to the difficulty of placing the educated boys in suitable occupation is repeated. The main difficulty is ascribed to the weakness of agriculture and the low level of economic life in the islands. "Agriculture everywhere will continue to offer too little reward and too low a status to attract the ambitious until it is re-organized to give more scope for the use of hard-won learning." No indication however is given as to how that "re-organization" is to be brought about in Islands with very limited space and resources. Favourable criticism is in some measure devoted to certain school gardens in the West Indies, but the suggestion is made that more attention should be paid to the organization of schools as community centres.

The author discusses at some length the plantation system of agriculture and the possibilities of peasant proprietorship. Although the references to these systems is in many

instances correct and fair, yet there is much confusion, owing no doubt to lack of detailed knowledge, in representing their relative advantages and disadvantages, and there is little definitely helpful for the formulation of a constructive policy of future development and maintenance of agricultural industry. The plantation system has been somewhat harshly and perhaps unfairly criticised, and its 'failure' has been attributed entirely to its internal defects without reference to such external factors as the smallness of the total quantities of produce for export, distant markets, transport difficulties and low market values. It must not be overlooked that any system of agriculture which replaces the plantation system will be faced with the same external factors, which are in reality the real factors affecting the prosperity and social standard of the inhabitants in the Islands. It is noteworthy that the author has failed to make reference to these factors of such fundamental importance.

In the final chapter of the book the author discusses the possibilities of social and economic reconstruction in the West Indies. It is here that the author presents various aspects of the problem which might usefully be studied by those immediately concerned. He strongly favours trying out "the fuller possibilities of peasant proprietorship", which, he states with much satisfaction, "has at last come to be the avowed aim of the Island Governments". The impression is given that the substitution of peasant agriculture for the plantation system will go a long way to solve the problem and to place the poorer classes of the inhabitants on a better social level. Several important internal factors are however passed over without mention. For instance, the relatively small amount of suitable cultivable land, in the smaller Islands especially, compared with the size of the populations. Another is the question of the cultivation of food crops. It is questionable whether the people can be suitably fed all the year round and whether economic stability can be maintained by the cultivation of the type of food crops that can on the average be grown. The limit in the usefulness of food crop production might be reached much sooner than expected. It is useless, for example, advocating the production of corn in these Islands when the producers themselves buy and eat in *preference* corn imported from Argentine.

The author describes the several forms of peasant agriculture in the Islands, namely peasant proprietorship, tenancy, metayage and cane-farming. They all have their advantages and disadvantages. The author has not overlooked the fact that "social and economic issues are inextricably interwoven". He states that "the social independence of "small-holders is a real gain", and that "the justification of peasant proprietorship as it is now is definitely social rather than economic". It is important that he has realized some of the dangers and difficulties of promoting and effecting peasant settlement schemes and has sounded a real "warning *to* the West Indies" in the following—"But if the West Indian revenues are ever to suffice to make up the deficiencies of the administration, and especially to provide essential social services, the resources of the Islands must be more fully developed. By this economic test peasants and small tenants alike fall short. On any showing the quality of their agriculture is second-rate, often deplorable". The author has done well therefore to conclude that peasant development by itself inevitably becomes "an inferior thing apart from the agriculture that matters". Then for the future. He states that agriculture has become a science, and marketing an art, and that it is not to be tolerated that a handful of land-owners should be maintained unconditionally whatever the quality of their work. "The more enlightened planters are ready to co-operate for the reconstruction of agriculture—and the weak individual must inevitably submit to some collective organization which will eliminate the incompetent". The author now comes face to face with the inevitable difficulty of *finance*, but he does not overcome it. He merely states "the great Banks could help if they would", and suggests liberal donations from Imperial funds—"to meet this problem more is needed than the Colonial Development Fund as now restricted". The author therefore leaves us, assuming apparently that the financial difficulty *can* be overcome, with the ideal or Utopian situation which is suggested in the following quotation:—"The industry itself, organized in all its branches, should fix its own standards, decide for example who have or who have not qualified for financial help and, in the spirit of a guild of master craftsmen, exclude the incompetent. Then, and only then, it may be economically possible to absorb peasants and small tenants in the system and to use effectively the labour of which there is now a super-abundance".

C. C. S.

* * *

KENYA: CONTRASTS AND PROBLEMS.

By L. S. B. Leakey. *Methuen & Co.*, London, 1936, xiii+186 pp., illust., *7s. 6d.*

This little book is a notable contribution to the problems of African administration, for Dr. Leakey has both destructive and constructive criticism to offer, alike on the policy of the Government and the actions of the European settlers in Kenya. That the author is thoroughly qualified to write about his own country—he was born and bred there—is evident from his familiarity with its difficulties, and he presents very fairly both sides of the many problems which beset native administration in Kenya. Unfortunately, in the very vexed question of overgrazing and its consequent effects, Dr. Leakey allows his zeal to run away with him, and does not appear to realise that one cannot 'get a quart into a pint pot' and that habitual overgrazing, whatever the purpose for

which the stock are kept, will inevitably ruin the land. It is worth recalling (*Tropical Agriculture*, Vol. XIII, pp. 57-58) that evidence was given before the Carter Commission, that the Machakos district was carrying about six times the number of cattle it could reasonably accommodate, as well as large numbers of sheep and goats. Dr. Leakey's suggestion to utilise the game reserves would at best only postpone the danger. Nor is the author quite fair to the officers of the Agricultural and Veterinary Departments, when he implies that they "habitually regard African methods as inherently bad, simply because they are different from our own," for he does not realise "that European methods of research are being used to develop African methods of cultivation". A brief perusal of the annual reports of the Departments concerned would have saved him from this error, and it is a pity that Dr. Leakey spoils his case in this way. This is not to imply that the book is not worth reading, for it is full of valuable suggestions. The last chapter on the future of Kenya will be read with interest by all those who are attached to this "land of contrasts".

R. C. W.

* * *

PLANTS FROM MESOPOTAMIA.

A Distributional Note.

By John Anthony. *R. B. G.* Edinburgh, No. XC, pp. 277-303, 1 map.

Knowledge of the flora of the 'Iraq has been much extended by Mr. Anthony's excellent paper. To the 404 genera comprising 745 species, already described by Evan Guest*, Mr. Anthony now adds 94 genera and 490 species to the known 'Iraqi and ten species found in Iran. The list has been compiled from 2,049 specimens collected by Professor R. J. D. Graham, Mr. C. C. Calder, Dr. G. K. Sutherland and Mr. W. E. Evans between the years 1917 and 1919.

The orders represented in the 'Iraq by the greatest number of species, as shown by Mr. Anthony's list are :—

1. Leguminosae	 32	genera	106	species.
2. Compositae	 53	,,	105	,,
3. Graminae	 42	,,	101	,,
4. Cruciferae	 28	,,	73	,,

The comparative richness of the 'Iraqi flora in the Leguminosae is particularly striking and it is probably due to the common occurrence of plants of this order that 'Iraqi soils have been able to maintain their fertility, despite the unfavourable climate. Uses, local names, and descriptions are not given but against each species listed the name of the locality where the plant was found is recorded. It would avoid confusion if the place names were spelt either according to the present day official spelling or to the recommendations of the Royal Geographical Society. Khanaqin is not in Iran but in the 'Iraq.

* *Tropical Agriculture*, Vol. XI, No. 1, pp. 20-21.

It must be a matter of satisfaction to every Arabic scholar that the genus *Schismus* has at last been reported from the 'Iraq.

It is to be hoped that the 'Iraqi Department of Agriculture will see its way to re-issue Mr. Guest's notes with the addition of Mr. Anthony's newly reported species as this would make a valuable bulletin.

The following typographical errors are noted :—

Page 282 for H. Lippii Dum. Cours. read *H. Lippii*, Pers.
,, 284 ,, E. bryoniifolium read *E. bryoniaefolium*.
,, 287 ,, C. scorpiodes read *C. scorpioides*.
O. Cristi-galli read *O. Crista-galli*.
,, 288 ,, Prosophis read *Prosopis*.
,, 289 ,, C. cutularia read *C. cucullaria*.
,, 291 ,, .M. aurea Sch.-Bip. read *M. aurea*, (L) J. Gay.
,, 292 ,, K. linearis read *Koelpinia linearis*.
L. fallax O. Kuntze read *L. fallax*, Muschl.
,, 294 ,, O. albo-rosea read *O. albo-roseum*.
,, 295 ,, Ocymum read *Ocimum*.
S. strofitziana read *S. szovitziana*.
,, 297 ,, E. helioscopa read *E. helioscopia*.
,, 298 ,, A. telephoides read *A. telephioides*.
,, 299 ,, A. tenuifolia read *A. tenuifolius*.
B. ciliata read *B. ciliatus*.
O. narbonense read *O. Narbonense*.
,, 301 ,, S. torilis read *S. tortilis*.
,, 302 ,, B. matritensis read *B. madritensis*.
Agropyrum read *Agropyron*.

Owing to the scarcity of reference books in Basrah, Mr. A. R. Horwood of Kew has been kind enough to verify the above list of corrections.

* * * V. H. W. D.

NIGERIA.—A CRITIQUE OF BRITISH COLONIAL ADMINISTRATION.

By W. R. Crocker, *George Allen & Unwin, Ltd.* London, 1936, pp. 278, price 10*s.* 6*d.*

Mr. Crocker was in the Nigerian Administrative Service up to the middle of 1934 and the first part of this book consists of extracts from the diary kept by him until June, 1934. It is not clear when he left the Colony, but presumably since leaving, he has produced a book on the Japanese population problem. The introduction to the present volume is dated January, 1936 at Geneva.

The diary makes interesting but not exciting reading, and it is to the second part of the book, which is described as a tract on Colonial Administration, that most readers will turn. The author is deeply interested in problems of public administration, and levels some very forcible criticisms against the Nigerian Administration, and the general administration of the Empire. These criticisms are both destructive and constructive, and though the reader, suspecting perhaps that the picture is at times overcoloured, will not be prepared to accept all that Mr. Crocker says, there is food for abundant thought for any one who is interested in our African Colonies. The book is a welcome contribution to the proper understanding of some of the problems of Colonial policy which are to-day coming so much under discussion.

R. C. W.

THE "CONTROL" OF INSECTS BY HAND-COLLECTION—A REVIEW OF LE PELLEY'S WORK.

It has happened to me time and again, in various parts of the world, from the dried-fruit packing-sheds of Australia to the cane-fields of Demerara, from the stockyards of New Zealand to the warehouses of the London docks, that, after demonstrating some abundant insect pest to the business man, planter or farmer, I have tossed away the insect from my hand, whereupon he has urged me to kill it, or has killed it himself, on the plea that it was one less. That is the psychology which is behind the continued popularity, in the mind of the so-called practical man, of methods of hand-collecting insect pests. In other words, as Le Pelley says, "The planter believes that every insect caught is one less to eat the crop, and that therefore the value of the method is in direct proportion to the number of insects picked off . . ."

In no part of the world are hand-collection methods against pests so popular as they are in the West Indies and British Guiana. I have long pointed out that there is no evidence that any of these methods are efficient; but in spite of depression in industry and economy in other directions, notably in primary research, in most cases this blind accumulation of scalps continues.

Mr. Le Pelley*, working in Kenya, has now examined statistically the method of hand-collection as applied to the coffee bug (*Antestia orbitalis*) and questions its efficiency against this and most other pests. As an extreme instance of the method, Le Pelley quotes the situation in Mauritius with the hard-back (*Phytalus smithi*) on sugar cane. It is "recorded that since 1911 nearly two thousand million insects had been destroyed in Mauritius, apparently chiefly or only by hand-collection and digging of larvae, at a cost of nearly a million rupees", and the entomologist responsible "stated that there could be little doubt that this expenditure was entirely justified. If such be the case [continues Le Pelley] it is not shown by his figures. The area of cane attacked increased from about 3,000 acres in 1911 to 46,000 acres in 1930".

As a result of his experiments on the hand-collecting of coffee bugs, Le Pelley obtained a curve which is "essentially similar to the curves postulated by Fiske (1910) and Nicholson (1933). Fiske speculating on what would happen in certain fixed conditions of parasitism plotted the number of eggs laid by a parasite against the number of unparasitised hosts. As the number of eggs laid increased there was a progressive increase in the possibility that the host chosen for oviposition had already been parasitised and a curve was produced apparently similar to the above (Le Pelley's) but for which no expression was obtained. Nicholson used a similar curve originally obtained from arithmetical postulates, which he called the 'competition curve'. This was based on the success of animals in random searching, and he plotted the area traversed, representing the total amount of searching carried out by the animals, against the area covered, representing the area within which the objects sought were found. In the present experiments the native collectors represent the searching animals, the time spent on the work represents the amount of searching, and the percentage obtained of the total *Antestia* present represents the area covered. The correspondence of this curve obtained experimentally with one based on theoretical postulates in a different though similar problem is of interest. *It is clear therefore that in so far as hand-collection approximates to random collection, as it must in nearly all cases with small insects on large plants, the conclusions drawn are valid*". (Italics mine.)

In summary Le Pelley found that "The rate of increase of the yield of insects collected falls off in a definite and measurable manner as the time spent on the work increases. The formula for the curve fitting the results is $P = 100\ (1 - (V.e.)^{-t})$ where 'P' is the percentage collected of the total *Antestia* present, 't' is the time spent collecting and 'V' is a coefficient which has different values according to the conditions prevailing . . . The results show that in theory 100 per cent. of the insects can never be obtained by hand-picking, and that in practice the cost of picking and adequate percentage is almost invariably prohibitive".

"Details of a thorough long-continued attempt to control *Antestia* on 35 acres of coffee by handpicking are given. The attempt proved unsuccessful, and it is suggested that it may actually have been responsible for the maintenance of the severe attack."

When detailed enquiries were last made, two or three years ago, a sum not less than $42,000 was being expended annually on the hand-collecting of insect pests in the sugar industry alone, of Trinidad and British Guiana; and enquiries this year in the two Colonies did not show that any estate which maintained a borer-gang two years ago had discontinued it. It is possible that some of the borer-gangs have been reduced as an economy measure, and it is known that on some estates they are employed not exclusively for insect control. It seems probable that few planters realise how much is spent on these methods of direct control. The sum mentioned is more than twice as much as would suffice to maintain a biological control service proportionately comparable to that of Hawaii.

J. G. MYERS.

* R. H. Le Pelley—Observations on the control of insects by hand-collection. *Bull. Ent. Res.*, XXVI, pp. 533-541, 3 figs., 1935.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Production of Butyric Acid from Blackstrap Molasses.—*Rafael Arroyo.*

Up to the present, the fermentation of molasses to butyric acid has been unsatisfactory, as the fermentation produces other substances in too great a proportion for the process to be a commercial proposition.

Two years of research by the author has culminated in the isolation of a bacillus that is capable of producing nearly the theoretical possible yield of butyric acid.

The organism is facultatively anaerobic and exceptionally vigorous, so that it competes successfully with other organisms which may gain access to the fermenting liquid. These two facts are of the first order of technical importance.

The optimum conditions are produced by the presence of sufficient calcium carbonate to neutralize the acid produced, a total sugar concentration of 6.6 per cent. on mash and a temperature of 30 to 32°C.

The yield is given as between 43 and 45 per cent. on total sugars, and the cost of production as eight to ten cents per lb. which is in favourable contrast with prevailing prices.

* * *

Monochromatic Sodium Light in the Sugar Factory Laboratory for Illuminating the Polarimeter and Refractometer.*—*Jaroslav Pucherna.*

In optical measurements with white light in sugar factory laboratories one manages quite well with quartz wedge compensation, which depends on the assumption that the dispersion of the sucrose solution and of quartz is the same. White light measurements only present difficulties when dealing with sugar solutions that are not quite pure, the non-sugars having a dispersion which cannot be exactly compensated by quartz.

Now, however, that electric sodium lamps exist, the manipulation of which is almost as simple as that of an ordinary incandescent electric lamp, and the price of which is not disproportionate considering its life, it is possible to enjoy the advantages of monochromatic light in sugar factory laboratories.

This likewise refers to refractometry when in measurements of molasses, after-products, dark oils and fats, the setting of the boundary line is difficult, even when in the Abbe instrument the Amici prism (or compensator) is used. By using monochromatic light, uncertain readings in this instrument become distinct.

Likewise in polarimetry even when relatively very pure solutions (freed from non-sugars by clarification) are under observation more accurate readings are obtained with sodium light. When dark yellow though clear solutions, as those of molasses, after-products, or raw sugars, are polarized, readings are uncertain and tedious, especially in old dull half-shadow apparatus; whereas with monochromatic light the field of vision with such products is better illuminated and the end-point clearer. It is also less tiring to the eyes with this illumination to deal with a large number of observations.

Observer.	Quartz Plate.		Sucrose.	
	White Light.	Sodium Light.	White Light.	Sodium Light.
A ..	0.049	0.024	0.058	0.033
B ..	0.048	0.016	0.041	0.026
Av. ..	0.048	0.020	0.049	0.030

Observer.	Raw Sugar.		Molasses.	
	White Light.	Sodium Light.	White Light.	Sodium Light.
A ..	0.041	0.016	0.069	0.024
B ..	0.050	0.000	0.070	0.000
Av. ..	0.045	0.008	0.069	0.012

In the table is given a statement of the extent of the ± average error (in °V.) of an observation in measuring a quartz plate, a pure sucrose solution, a raw sugar solution, and a molasses solution, using on the one hand monochromatic light and on the other light from an "Argenta" incandescent electric lamp. Each reading was the average of ten observations by two operators.

It is clear from this table that in using monochromatic light in half shadow polarimeters the precision of a reading is distinctly greater than in the white light quartz wedge compensation instrument. Striking is the improvement with dark yellow solutions (*e.g.*; half normal molasses solutions), where the extent of the average error is only a fraction of the corresponding value for white light. Less remarkable is the improvement with the lightly coloured solution of refined sugar, and with the quartz plate.

Particulars of electric sodium lamps have already been given in these columns*. According to the maker's statement, its intensity is about eight candles, and its composition principally corresponds to the two D-lines of the spectrum (4890 Å and 5896 Å), and can for most purposes be assumed to be monochromatic. Other wavelengths amount to 0.5 to 1 per cent. of the total, separable when necessary by means of suitable filters. As for the life of the lamp, the manufacturers claim 1,000 hours, and its price is relatively low.—(*International Sugar Journal* Vol. XXXVIII, No. 449, pp. 184-185, 1936.)

* An article on this subject was recently published. *See I. S. J.*, 1935, pp. 474-476.

* *I. S. J.*, 1931, p. 245; 1932, pp. 282, 407.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Milk in Adult Nutrition.

The following figures show the part played by milk in the ordinary diet :—

	Requirements of a daily diet 2,400 calories.	*Content of 1 pint of milk.*
Protein	73 gm.	17.0 gm.
Fat	72 gm.	17.0 gm.
Carbohydrate	365 gm.	26.5 gm.
Calcium	1.0 gm.	0.69 gm.
Phosphorus	1.32 gm.	0.534 gm.
Iron	0.015 gm.	0.001 gm.
Vitamin A	3,000 units	1,462 units (summer) 468 units (winter)
Vitamin B	900 units	117 units
Vitamin C	30 units	11.7 units

Thus 1 pint of milk per day can supply $\frac{1}{4}$ of the protein, $\frac{1}{4}$ of the fat, $\frac{2}{3}$ of the calcium, $\frac{1}{3}$ of the phosphorus, $\frac{1}{2}$ of the vitamin A, $\frac{1}{9}$ of the vitamin B, and $\frac{1}{2}$ of the vitamin C, if unpasteurized. Milk is deficient in carbohydrate, iron, and vitamin D.

It is as a source of calcium that milk is so important, if not absolutely essential. While one pint of milk contains 0.69 gm. calcium, one pound of meat contains 0.058 gm., and one pound of lettuce 0.215 gm. Even although half the calcium in milk is not assimilated by the body, it has been found that one pint of milk a day, *plus* an ordinary diet ensures an adequate calcium intake. In an experiment with 109 women the calcium intake was graphed against percentage fitness, and it was found that calcium has a very great influence on general health, an intake of 1 gm. giving A1 standard. It was also found that complexion in adults is influenced favourably by a high calcium diet, but teeth and physique are more influenced by diet in childhood. Overweight does not run parallel to milk intake, thus exploding a fallacy that drinking milk causes stoutness.—(*Chem. & Ind.*, Vol. LVIII, No. 8, p. 148, 1936.)

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Mycorrhiza in Citrus.

The following note is taken from two letters to the Editor of *Nature*, written by Dr. M. C. Rayner, Bedford College, London, who is one of the world's foremost authorities on root infesting fungi called mycorrhiza. Dr. Rayner visited California in 1933 to study the mycorrhiza of *Citrus*, and her two letters on the subject appeared in the 1st March, 1933 issue of *Nature*, and in that for 28th September, 1935.

Experience in California and elsewhere has shown that nitrogen supplied to *Citrus* trees as sodium nitrate or similar inorganic compounds gives poor results, whereas sodium nitrate treatment, combined with stable manure or rapidly decomposable organic matter in the form of cover crops, is highly beneficial. No satisfactory explanation of these differential results has yet been offered, but the recent discovery of the association between mycorrhiza and the root-system of *Citrus* trees may at least partly account for the observations. It suggests that the organic materials supplied to the soil furnish appropriate food to the root fungus (mycorrhiza), and provide the conditions requisite for root infection. The mycorrhiza which penetrate the root cells of the tree are digested, and part of their metabolised products eventually pass into the tree.

The roots of many *Citrus* species, such as the cultivated orange, are remarkably deficient in root hairs, especially when grown in neutral or alkaline soils like those occurring in California where *Citrus* is cultivated under highly artificial conditions. It would be interesting to know if a similar type of root infection by mycorrhiza occurs in species used as stock when growing in their native natural environments. In view of the heavy cost of manuring in Californian orchards and the inconsistent responses shown by the *Citrus* trees, it is obviously important to ascertain whether different treatments and results can be definitely correlated with the condition of the roots in respect to mycorrhizal infection.

Such an investigation was lately undertaken by H. S. Reed and T. Frémont at the Citrus Experimental Station of the University of California (*See Phytopathology*, 1935, 25, p. 645). The results justify the views expressed above, and led the authors to emphasise " the importance of the mycorrhizal association as a factor in the metabolism of *Citrus* root cells ", and to conclude that " the relations between the root cell and the endophytic fungus contribute to an understanding of the responses of the tree to nitrogenous fertilisers, and to the conditions favourable for infection by the endophyte ". The mycorrhiza found at the roots of cultivated *Citrus* in California was similar to that found in the same species under natural conditions.

Dr. Rayner urges in her second letter " the need for expert diagnosis of root condition in respect to mycorrhizal equipment as an index of soil environment favourable or the reverse, and as a guide to efficient manurial treatment of crops showing regular mycorrhizal associations ".

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Technical Products from Coconut Oil Wax.

Coconut oil deposits a sediment on standing in tanks. The exact amount of sediment is not known, but it was surmised in one mill that 500 tons of oil would deposit about 40 kg. of sediment in three months, while other estimates are higher. This coconut oil residue has been identified as a wax consisting largely of the myricyl ester of cerotic acid. A floor wax, a furniture polish, and a leather polish were prepared from the residue.—(*Philippine Journal of Science*, Vol. LVII, p. 423, 1935. Abstr. in *Analyst*, Vol. LXI, p. 136, 1936.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observation is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.).

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
30th April	4	10½	8	7½
7th May	4	9¾	8	6¾
14th May	4	9	8	6
21st May	4	9¾	8	6
28th May	4	8½	8	5¼
4th June	4	9¼	8	6
11th June	4	9	8	5¼
(13th *June*, 1935)	4	9¾	8	6¾

Despite the considerable improvement in the statistical position of sugar prices have remained unresponsive. The market is affected by the knowledge that actual production is far below potential output, and that any shortage caused by adverse conditions in one country can be readily made good by other producers. The tone of the market remains firm but shows no evidence of a trend in either direction.

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RUBBER.—Quotations for plantation sheet have ranged as follows:—

	Pence per lb.
29th April	7 3-8
6th May	7 3-8
13th May	7 5-16
20th May	7 3-8
27th May	7 5-16
3rd June	7 5-16
10th June	7 5-16
(12th *June*, 1935)	6 1-16

The International Rubber Regulation Committee decided upon an extra release of five per cent. for the last six months of the current year. The effect on prices was less than expected. The out put of motor vehicles in the United States of America and United Kingdom shows an appreciable increase this year compared with last year. Stocks in the United Kingdom on 23rd May, 1936, amounted to 132,745 tons showing a decline of 24,110 tons in 12 weeks and being lower than any other week since 15th December, 1934, when they were 132,499 tons. On 14th September, 1935, stocks stood at 178,012 tons. Shipments from Malaya during April were 10,500 tons less than those in March. Despite the improvements in the statistical position the market has been inactive. The market has been dominated by the fear of a possible devaluation of the French currency followed by similar action in Holland.

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GRAPEFRUIT.—Quotations 18th May, 1936, were: Jamaica and Trinidad 14*s.* to 20*s.* per case. Quantities were light and were in good demand. Shipments from Palestine have finished for the season. Shipments from British Honduras were of excellent quality and sold well.

COCOA.—During the past month the cocoa market has been firm especially for West African descriptions. Manufacturing support has been forthcoming in all markets and a steady market to gradual improvement is anticipated until the weight of the new crop is felt. Then possibly there will be a little re-action. Today's quotation for new crop Accra is 28*s.* c.i.f. and locally the market is very firm at $9.75 per fanega.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

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COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
24th April	6.62	9.15
1st May	6.46	8.89
8th May	6.46	8.96
15th May	6.56	9.03
22nd May	6.57	8.87
29th May	6.64	—
5th June	6.68	—
12th June	6.82	—
(14th *June*, 1935)	6.76	8.05

There has been little change in the level of prices, a fair business being transacted with sellers more prepared to meet buyers. Fair business has passed in Americans for forward delivery. There have been small sales of West Indian Sea Island Cotton at 18½*d.* to 21¼*d.* per lb. The Liverpool correspondent of the *West India Committee Circular* reports that, "All the larger spinners are not prepared to pay more than 18*d.*, otherwise they state that the demand for Sea Island underclothing will fall off very considerably".

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BANANAS.—Jamaicas remain in good demand at £18 5*s.* delivered London. Brazilians are unchanged at £15 nearest station.

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COFFEE.—Offerings have been lighter and the market very dull. Nearly all the main crops have practically finished. Superior Santos c. & f. was quoted at 38*s.* New arrivals of Blue Mountain Jamaica realised up to 193*s.* for bold sizes.

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LIME PRODUCTS.—*Lime Oil.*—There are sellers of Handpressed at 37*s.* 6*d.* per lb. The demand for Distilled continues slow, and there are still sellers at 22*s.* 6*d.* per lb. *Lime Juice.*—There is no demand for Concentrated. Raw is steady but quiet and unchanged at 2*s.* to 2*s.* 6*d.* according to quality.—(*West India Committee Circular*, 21st May, 1936.)